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Americans on the wrong side – the lobster *Homarus americanus* captured in Norwegian waters

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In November 1999, two female lobsters, one with external egg batch, were captured in the common lobster fishery in the Oslo fjord, Norway and reported as possible American lobsters, *Homarus americanus,* to Bergen Aquarium and the Institute of Marine Research. More, but undersized specimens were said to be present in the fishery. After this six more American lobster has been captured on other part of the Norwegian coast, both escapees from people importing them illegally from abroad. Some were banded, or showed sign of recent banding.

Closer inspection confirmed that the two individuals first registered showed a series of American characteristics, as a ventral tooth on the rostrums, longer and sharper teeth inside the cutter claw and the typical greenish-brown colour common in American lobsters. Tissue sample from additional four specimens were analysed by starch gel electrophoresis and all possessed new alleles, never reported in European lobster before, at several allozyme loci. These alleles correspond to common alleles in American lobsters as demonstrated in a reference sample. Origin and time of invasion of the American lobsters are suggested, as well as possible ecological interactions and influence on the original lobster population when invaded by this competitor.

Keywords: *Homarus americanus*, *Homarus gammarus*, ecology, genetics, hybridisation

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Introduction

Crustaceans, along with the molluscs, are animal phyla highly potential for invading new areas outside their original home-areas and make successful establishment (Kinzelbach 1995; Cohen & Carlton 1995; Glassner-Shwayder 1996; Clare Eno et al 1997; Morton 1997; van der Velde et al. 2000). The caprellid *Caprella muticata* has recently been found in dense populations on fish farms along the west coast of Norway and the shore crab *Hemigrapsus pennicillatus* are apparently spreading out from the Bay of Biscay, where it was introduced few year ago (Noël et al 1997; Gollasch 1999). Both these species are distributed to new areas by ballast water or clinging to ship hulls.

One year ago another exotic crustacean was registered in Norway, the American lobster *Homarus americanus*. The annual landing of this species is 40 times the landing of European lobster *Homarus gammarus* in Europe as a whole (Wahle 1998). This paper will present the registered individuals, the histories behind their introduction to Norwegian waters, some of the worries occurring after introduction of this large-sized, long-lived species and what we intend to do in response to these findings.

Status quo, worries and further plans

Sampling procdure

A co-operation between local fishermen, Drøbak Aquarium, Bergen Aquarium and the Institute of Marine Research commenced in year 2000. The fishermen will kept diary on their catch and should deliver any "suspicious" lobster live to the Drøbak Aquarium for specification. Bergen Aquarium picked up and housed the American lobsters that were caught and the Institute of Marine Research analysed the fishing diaries. The Institute of Marine Research also do the genetic analyses. In addition, a public warrant has been published, presenting addresses to delivery stations were live lobsters can be delivered for specifications, also outside the inner Oslo fjord. The Bergen Aquarium and the Institute of Marine Research were responsible for this project.

During year 2000, a series of persons at local aquariums, coastal research stations and lobster landing facilities were trained in distinguish between the two lobster species. It turned out to be difficult to make good specification based on the present morphological keys. By the end of 2000, 23 new lobsters had been delivered and accepted for analyses, in addition to the first two. They came from the Swedish border north to Ålesund in Western Norway (Fig. 1).

Description of the registered lobsters

The lobsters have so far been fully investigated by inspection and measuring of their morphology (Table 1). They have all or some some of the American characteristics with a dorsal point on the rostrum, fine spines as well as saw-shaped points in the cutting claw, reddish spines and rostrum points and greenish brown colouration (Fig. 2 a-d)(Table 1). Five were females and two males between 90 and 106 mm CL. The last one was not sexed. One of the females carried eggs, as well as egg remnants, indicating that larvae had been hatched immediately before capture.

Genetic samples have been sampled from 21 of these lobsters, and the six has so far been analysed. Four show distinct patterns from European lobsters when analysed by starch gel electrophoresis. Some new alleles, never reported in European lobster before, were found at several allozyme loci (Fig. 3 a, b). These alleles correspond to common alleles in American

lobsters as demonstrated in a reference sample. Further analyses are on their way, both as starch gel electrophoresis and DNA analyses. Also DNA analyses will be taken, to look for possible hybrids among these lobsters.

Introduction mechanisms

The history behind the two first registered American lobsters seems to be going approximate 13 years back in time. It is said by local informants that a quay-side seller released about 10-14 live American lobsters at the end of a day late in the 1980's, in the middle of Oslo, situated in the inner part of the Oslo fjord and a second release of six more in the same area in 1992 (Fig. 1).

About the same time, a teacher in a primary school in Oslo called Flødevigen Biological Research Station, for advice in their attempt to rear lobster larvae as a classroom project. It was suspected at that time that they reared on American lobster juveniles, but the suspicion was not verified. We have today no more information about what happened to the rearing project. If the juveniles were released, they would be about the size of the captured American lobsters from that area.

The last two lobsters, found further south along the Norwegian coast (Fig. 1), were both captured with rubber bands around their claws, or at least clear friction marks from rubber bands. It is reported that one unknown person around New Year 2000 brought eight lobsters from Canada to Norway. They were stored alive in the sea for later consumption, but all escaped.

Practically all the positive findings of America lobsters are from areas nearby larger cities and airports with frequent traffic in or out of the country.

Potential problems caused by the intruder

There are several problems that may occur when a new species is introduced. American lobsters are in many ways quite like European lobsters, but in some ways very different (see Table 2). When the European lobster reached historical low density in the area for the lasts decades (Rørvik and Tveite 1989), even a low numbers of intruders might make a significant impact. Potential problems might be related to resources as shelter and food for all life stages, social interactions and with a possibility that hybrids might be produced. These problems will be looked into in adult lobsters in pilot studies as presented below. Other potential problems are the effect in the local biodiversity in general, along with disease. The most threatening disease is the Gaffkemia. This bacterial disease can be carried by some American lobsters but is 100% lethal in European lobsters. As long as the wild population is purebred European lobsters, this disease has little chance to be spread, as the lobsters die within days after contamination. With American lobsters present, they might act as vectors and carriers also in the sea. In addition, the European lobsters from Nordic waters have a particularly striking black or bluish black colouration and a rareness that make them high-value gourmet products. The Norwegian fishermen will have little to gain if the more brownish American lobster, landed in tens of thousand of metric tons along the northwest American coast should substitute our original lobster.

What next? Management response to the introduction

The occurrence of American lobsters in Norwegian waters has caused some worry. This is a long-lived, large and very competitive species, which apparently has a lot in common to the

European lobster (see Tab. 3). The European lobster has been through a population breakdown in Norway since the 1950's, and money and time has been put into research to enhance the current population (Agnalt et al. 1999). Our results indicate that the occurrence of American lobsters in Norway is scarce but widespread, and that new releases probably occur each year.

Norway has signed an International Convention to protect local biodiversity and is obliged to follow up on introduction of clearly exotic species. The Department of Fisheries and the Fisheries Directorate raised money for this study on density and occurrence of American lobsters in the inner Oslo fjord. The next project will be to do behavioural experiments with both species together in tanks, to look at specific differences in ability to protect shelter and food, how social communication work between the species, and look for mating attempt between the species. Hybrids have been produced in laboratories, but most often by artificial insemination (Adouin & Leglise, 1972; Carlberg et al 1978; Hedgecock et al 1977).

The results of these initial studies will be important for further action. We will still have no information about the survival success in larvae and juvenile American lobsters settling in Norwegian waters, how hybrids develop and if these are fertile or not. Some publications report male hybrids to be infertile while female hybrids produce eggs (Talbot et al 1984; Bowser & Rosemark 1981). The viability of these eggs is not known.

It is allowed for fishmongers to import live American lobsters, as long as they are kept in land-based tanks where the outlet water is thoroughly rinsed. They must be boiled before they are brought to the market. It is not allowed to import live American lobsters to be held in the sea, to avoid infection of the lobster disease Gaffkemia in Norwegian waters. Yet, during the last year it seems that release and/or escape of live American lobsters might be a bigger problem than expected. This is probably true for all European countries and the presence of American lobsters should be expected also in other coastal areas. An international search, at least all along the European Atlantic coast would be needed to document for the full range of American lobsters in Europe.

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References.

Audouin, J. & Leglise, M. 1972. Premiers résultata d'expériences relatives aux possibilités d'acclimatation de homard américain *Homarus americanus* en France. ICES CM E:34.

Atema, J. & Voigt, R. 1995. Behavior and sensory biology. In: Biology of the Lobster *Homarus americanus* (ed. J.R. Factor) Academic Press, San Diego: 313-348.

Bowser, P.R. & Rosemark, R. 1981. Mortalities of cultured lobsters, *Homarus*, associated with a molt death syndrome. *Aquaculture* 23: 11-18.

Carlberg, J.M., van Olst, J.C. & Ford, R.F. 1978. A comparison of larval and juvenile stages of the lobsters *Homatus americanus, Homarus gammarus* and their hybrid. In: Proceedings World Mariculture Society 9: 109-122.

Campbell, A. 1990. Aggretions of berried lobsters (*Homarus americanus*) in shallow waters off Grand Manan, eastern Canada. *Canadian Journal of Fisheries and Aquatic Sciences* 47: 520-523.

Clare Eno, N., Clark, R.A. & Sanderson, W.G. 1997. Non-native marine species in British waters: a review and directory. *Joint Nature Conservation Committee*. Peterborough.

Cohen, A.N. & Carlton, J.T. 1995. Biological study. Nonindigenous aquatic species in an United States estuary: a case study of the biological invasions of the San Francisco bay and delta. United States Fish and Wildlife Service, Washington D.C

Cooper, R.J. & Uzmann, J.R. 1980. Ecology of juvenile and adult clawed lobsters *Homarus americanus, Homarus gammarus,* and *nephrops norvegicus*. *Division of Fisheries and Oceanography Circulations* (CSIRO, Australia) 7: 187-208.

Cooper, R.A, Shepard, A., Valentine, P., Uzmann, J.R. & Hurlbert, A.1987a. Pre and post drilling benchmarks and monitoring data of ocean floor fauna, habitats, and contaminated loads on Georges Bank and its submarine canyons. *NOAA Symposium Series*, Underwater Research 2: 17-48.

Cooper, R.A., Valentine, P., Uzmann, J.R. & Slater, R.A.1987b. Submarine canyons. In: Georges Bank (red. R.H. Backus), MIT Press, Cambridge, Massachutes: 52-63.

Debuse, V.J., Addison, J.T. & Reynolds, J.D. 1999. The effects of sex ratio on sexual competition in the European lobster. *Animal behaviour* 58: 973-981.

Dybern, B.I.1973. lobster burrows in Swedish waters. *Helgoländer Meeresuntersuchung* 24: 401-414.

Free, E.K. 1998. Reproduction in the European lobster (*Homarus gammarus* (L.)). I The European Lobster *Homarus gammarus* (L.) Proceedings from the Seminar at Kvitsøy 1995 (eds. G.I. van der Meeren & O. Soldal), Fisken og Havet nr. 13: 4-25.

Glassner-Shwayder, K. 1996. Biological invasions. How aquatic nuisance species are entering North American waters, the harm they cause and what can be done to solve the problem. *Great Lakes Panel on Aquatic Nuisance Species.*

Gollasch, S. 1999. The Asian decapo *Hemigrapsus penicillatus* (de Haan, 1835)(Grapsidae, Decapoda) introduced in European waters: status quo and future perspective. *Helgoländer Meeresuntersuchungen* 52: 359-366.

Hedgecock, D., Moffett, W.L., Borgeson, W. & Nelson, K.1977. Progress and problems in lobster broodstock development. In: Proceedings World Mariculture Society 9: 497-506..

Holthuis, L.B. 1974. The lobsters of the superfamily Nephropidea of the Atlantic Ocean (Crustacea: Decapoda). *Bulletin of Marine Science* 24: 723-884.

Holthuis, L.B. 1991. Holthuis 1991. Key to species *Homarus americanus, H. capensis* and *H. gammarus*. FAO Species Catalogue vol. 13: Marine Lobsters of the World

Jensen, A.C., Collins, K.J., Free, E.K. & Bannister, R.C.A.1994. Lobster (*Homarus gammarus*) movement on an artificial reef; the potential use of artificial reefs for stock enhancement. *Crustaceana* 67: 198-211.

Karnofsky, E.B., Atema, J. & Elgin, R.H.1998. Field observations of social behavior, shelter use, and foraging in the lobster *Homarus americanus*. *Biological Bulletin* (Woods Hole) 176: 247-256.

Kinzelbach, R. 1995. Neozoan in European waters. Exemplifying the worldwide process of invasion and species mixing. *Experentia* 51: 526-538.

Lawton, P. & Lavalli, K.L. 1995. Postlarval, juvenile adolescent, and adult ecology. In: Biology of the Lobster *Homarus americanus* (ed. J.R. Factor) Academic Press, San Diego: 47-88.

Miller, R.J. 1989. Catchability of American lobsters (*Homarus americanus*) and rock crabs (*Cancer irroratus*) by traps. *Canadian Journal of Fisheries and Aquatic Sciences* 46: 1652-1657.

Miller, R.J. 1995. Fishery regulations and methods. In: Biology of the Lobster *Homarus americanus* (red. J.R. Factor) Academic Press, San Diego: 89-109.

Morton, B. 1997. The quatic nuisance species problem: a global perspective and review. I: *Zebra mussels and aquatic nuisance species* (red. F.M. D'Itri: 1-54. Ann Arbor Press, Chelsea, Michigan.

Noël, P.Y., Tardy, E. & d'Acoz C. d'U. 1997. Will the crab *Hemigrapsus penicillatus* invade the coast of Europe? *C.R. Acad. Sci. Paris, Sciences de la vie/Life sci.* 320: 741-745.

Pezzack, D.S. & Duggan, D.R.1986. Evidence of migration and homing of lobsters (*Homarus americanus*) on the Scotian Shelf. *Canadian Journal of Fisheries and Aquatic Sciences* 43: 2206-2211.

Roddick, D.L. & Miller, R.J.1992. Spatial and temporal overlap of the American lobster (*Homarus americanus*) and sea scallop (*Placopecten magellanicus*) as related to inshore dragging. *Canadian Journal of Fisheries and Aquatic Sciences* 49: 1486-1492.

Scrivener, J.C.E. 1971. Agonostic Behavior of the American lobster *Homarus americanus* (Milne Edwards). *Technical Report* – Fisheries Research, Board Canada 235.

Sheehy, M.R.J., Bannister, R.C.A., Wickins, J.F. & Shelton, P.J.M. 1999. New perspectives on the growth and longevity of the European lobster (*Homarus gammarus*). *Canadian Journal of Fisheries and Aquatic Sciences* 56: 1904-1915.

Smith, I.P., Collins, K.J. & Jensen, A.C. 1998. Movement and activity patterns of the European lobster, *Homarus gammarus,* revealed by electromagnetic telemetry. *Marine Biology* 132: 611-623.

Smith, I.P., Collins, K.J. & Jensen, A.C. 1999. Seasonal changes in the level and diel pattern of activity in the European lobster, *Homarus gammarus* (L.). *Marine Ecology – progress Series* 186: 255-264.

Talbot, P., Thaler, C. & Wilson, P. 1984. Spawning, egg attachement and egg retention in captive lobsters (*Homarus americanus*). *Aquaculture* 37: 239-249.

Uzmann, J.R., Cooper, R.A. & Pecci, K.J.1977. Migration and dispersion of tagged American lobsters, *Homarus americanus*, on the southern New England continental shelf. *NOAA Technical Report NMFS* SSRF-705.

van der Meeren, G.I. 1997. Preliminary acoustic tracking of native and transplanted European lobsters *Homarus gammarus* in open sea lagoon. *Marine and Freshwater Research* 48: 915-921.

van der Meeren, G.I. 2000. Kjemoresepsjon hos tifotkreps, med spesiell fokus på krabbe og krabbens reaksjon på spesifike lukter.(Chemoreception in decapoda, with focus on crabs and the crabs response to specific smells) *Internal note*, Institute of Marine Research, Norway. (in Noregian)

van der Meeren, G.I. & Agnalt, A.-L. 2000. Hummeren, populær og hemmelighetsfull. (The lobster, popular and mysterious). In: Havbruksrapporten 2000 (eds. Ø. Karlsen & A. Mangor Jensen), *Fisken og Havet* særnr. 3: 90-93 (in Norwegian)

van der Meeren, G.I. & Uksnøy, L.E. 2000. A comparison of claw morhpology and dominance between wild and cultivated European lobster. *Aquaculture International*, 8: 77-94.

van der Velde, G., Rajagopal, S., Kelleher, B., Muskó, I.B. & de Vaate, A.B. 2000. Ecological impact of crustacean invaders: General considerations and examples from the Rhine River.

Waddy, S.L., Aiken, D.E. & deKlein, D.P.V. 1995. Control of growth and reproduction. I Biology of the Lobster *Homarus americanus* (red. J.R. Factor) *Academic Press*, San Diego: 217-266.

Wahle, R.A. 1998. A trans-atlantic perspective on *Homarus* recruitment and enhancement. In: The European Lobster Homarus gammarus (L.) proccedings from the Seminar at Kvitsøy 1995. (Eds. G.I. van der Meeren & O. Soldal). *Fisken og Havet*, 13: 36-43

Wahle, R.A. & Steneck, R.S. 1991. Recruitments habitats and nursery grounds of the American lobster *Homarus americanus*: a demographic bottleneck? *Marine Ecology Progress* Series 69: 231-243.

Wickins, J.F., Roberts, J.C. & Heasman, M.S. 1996. Within-burrow behaviour of juvenile European lobsters *Homarus gammarus* (L.). *Marine and Freshwater Behaviour and Physiology* 28: 229-253.

Wolff, T. 1978. Maximum size of lobsters (*Homarus*)(Decapoda, Nephropidae). *Crustaceana* 34: 1-14.

Table 1. a). Details about landed American lobsters in Norwegian waters, time, fishing gear and location.

#.	Dateo	Depth (m)	Gear	Location	Total length (cm)	Sex	Ext. eggs	White spots	Colouration	Ventral rostrum spine
1	**Nov.99**		**Lobster trap**	**Bunnefjorden**	**24,2**	**Female**	**No**	**No**	**Brownish/green**	**Yes**
2	**Nov.99**		**Lobster trap**	**Bunnefjorden**	**27,5**	**Female**	**Yes**	**No**	**Brownish/green**	**Yes**
3	**Jul.00**		**Not known**	**Lillesand**	**30**	**Female**	**No**	**No**	**Brownish/green**	**Yes**
4	**Sep.00**	**5**	**Fyke net**	**Slemmestad**	**27,9**	**Female**	**No**	**No**	**Brownish/green**	**Yes**
5	**Sep.00**	**5**	**Fyke net**	**Sandefjord**	**28,8**	**Male**	**x**	**No**	**Brownish/green**	**Yes**
6	**May.00**	**60**	**Trammel net**	**Kristiansand**	**ca. 29**	**Female**	**No**	**No**	**Brownish/green**	**Broken**
7	**Sep.00**		**Not known**	**Ålesund**	**?**	**Male**	**x**	**No**	**Brownish/green**	**Yes, 2**
8	**Okt.00**		**Lobster trap**	**Kristiansand**	**Ikke innlevert**				**Brownish/green**	**Yes**
9	Sep.00	5	Fyke net	Tønsberg	23	Female	No	Yes	Darkbrown/white/blue	No
10	Okt.00	5	Lobster trap	Slemmestad	21,8	Female	Yes	Yes	Brown/Yellow	No
11	Okt.00	28	Lobster trap	Rauer-Svenner	25,3	Male	x	Yes	Black/brown/Yellow	No
12	Nov.00	23	Lobster trap	Herføl	34,7	Male	x	Yes	Darkbrown/Yellow	No
13	Nov.00	18	Lobster trap	Kråkerøy	22	Male	x	No	Brown/Yellow	No
14	Nov.00	16	Lobster trap	Ula	23	Female	No	Yes	Black/Yellow/White	No
15	Nov.00	40	Lobster trap	Ula	23,4	Female	No	No	Black/Yellow/White	No
16	Nov.00	28	Lobster trap	Svenner	22,4	Female	No	Yes	Tabby Yellow/Black	No
17	Okt. 00	12	Lobster trap	Fevikskilen	27	Female	No	Yes	Black	No, bent rostrum
18	Okt. 00		Lobster trap	Arendal	23,2	Female	Yes	No	Brown spotted	No
19	Okt.00	19	Lobster trap	Risør	24,7	Male	x	Yes	Black	Yes
20	Nov.00	22	Lobster trap	Arendal	18,8	Male	x	No	Brown spotted	Broken
21	Nov.00		Lobster trap	Arendal	20,5	Female	No	Yes	Black	Tendency
22	Des.00		Lobster trap	Kristiansand	?					
23	Okt.00		Lobster trap	Kvitsøy	?					
24	Nov.00		Lobster trap	Kvitsøy	?					

Next 2 pages:

Table 2. Comparison of published information about the American and European lobster.

American lobster	**Published information**	**European lobster**
Homarus americanus Milne Edwards		*Homarus gammarus* Linné
Geographical distribution: From Newfoundland, Canada, south to Cape Hatteras, South Carolina, USA (Holthuis 1974)		From Morocco, the Azors and the Black Sea, north to Nordland, Norway and Bohuslän/Skåne, Sweden (Holthuis 1974)
Depth range: 0-480 m, most common between 4-50 m (Holthuis 1974)		0-60 m, only a few observations deeper than 200 m (Holthuis 1974, van der Meeren unpubl.)
Age: • Expected: more than 30 years, more than 100 years is claimed from a public aquarium (Lawton & Lavalli 1995) • Max size: 19 kg/ 63,4 cm total lengde (Wolff 1978)		• Evaluated: Females: 60-70 years Males: 43 years (Sheehy et al 1999) • Max size: 8-9 kg/ 65 cm total lengde (Wolff 1978)
Egg diameter: Small (A.-L. Agnalt, IMR, Norway, pers. comm.)		Larger (A.-L. Agnalt, IMR, Norway, pers. comm)
Reproduction: • Smallest mature size, females: 72-102 mm CL (Waddy et al. 1995) • Fecundity: 10 000 – 100 000 eggs (Waddy et al. 1995)		• 80-85 mm CL (Free 1998, A.-L. Agnalt, IMR, Norway, unpubl. data) • 5 000 - 40 000 (Free 1998, A.-L. Agnalt, IMR, Norway, unpubl. data)
Hybridization: American males have been mated with European females in several studies (Adouin & Leglise, 1972; Carlberg et al 1978; Hedgecock et al 1977; Talbot et al 1984; Bowser & Rosemark 1981). The resulting hybrids had high survival rate, more rapid growth, European size and body shape with American traits. Male hybrids were reported to be sterile, females fertile.		**Genetics:** All methods for analyses tried so far have shown significant differences between the species. (Pers. comm. Knut Jørstad, IMR, partner in the EU sponsored project GEL, genetic mapping of lobsters in Europe.)
Migration: • Offshore lobsters: 20-40 % migrate seasonally to shallow waters in spring and back in autumn (Uzmann et al 1977) • Speed on the bottom, observed: 4,2 km daily. Estimated daily distance: 7,4 – 9,3 km (Uzman et al 1977) • Longest distance measured: almost 240 km (Pezzack & Duggan 1986) • Migration in ovigerous females (Lawton & Lavalli 1995)		• No long-distance migration found (Jensen et al 1993). • Longest distance measured: 18,5 km (Jensen et al 1994) • Normal scale: less than 500 meter (Smith et al 1998, b, A.-L. Agnalt, IMR, Norway upublished data)

Diurnal activity Peak at dusk and dawn (Karnofsky et al 1989)	Peak at dusk and dawn (van der Meeren 1998, Smith et al 1999)
Shelter habitat: Cobble, rocks and under solid objects on sand (see review in Cooper & Uzmann 1980)	Multi-entrance caves under solid objects on sand (Dybern 1973; Wickins et al. 1996), rocks (Jensen et al. 1994; van der Meeren 1997)
Behaviour: • Sensory biology: Chemoreception very important (see review Atema & Voigt 1995)	Not studied, but chemoreception reckoned as most important (van der Meeren, IMR, Norway, internal note 2000)
• Social communication: Chemical signals, body and claw postures, size of body and claws (see review in Atema & Voigt 1995)	Chemical signals expected, not studied, body and claw postures, size of body and (van der Meeren & Uksnøy 2000)
• Agonistic behaviour: Aggressive in captivity (see review in Atema & Voigt 1995), little physical aggression observed in the wild (Karnofsky et al 1998)	Sex bias seems to have impact on aggression level both between and within each sex (Debuse et al 1999) Aggression in juveniles seems to have negative connection to lthe quality of the shelter (T. kristiansen, E. Naustvold & K. Jørstad, IMR, Norway, unpubl. data)
• Dominance: Larger CL and claw area are important for being dominant. Thus males are usually dominant over females. (Scrivener 1971)	Males with larger CL and especially larger claw area are dominant over other males (van der Meeren & Uksnøy 2000)
Natural population density: • Adults, inshore: 1-3 lobster pr 100 ^{2}m (Miller 1989; Campbell 1990;Roddick & Miller 1992); offshore: 0-1260 hummer pr 100 ^{2}m, dependant of bottom substrate (Cooper et al 1987a; b)	• Not known
• Juveniles: App. 5, rarely 12 pr ^{2}m in cobble (Wahle & Steneck 1991), up to 3-5 pr ^{2}m in tidal pools and sea weed areas (Cowan 1999; Wahle & Steneck 1991)	• Not known
Fishery statistics, annually: • USA: 28 000 – 32 000 metric tons Canada: 40 000 – 60 000 metric tons (see review in Miller 1995)	Norway: 30 metric tons • UK: 1 250 – 1 500 metric tons • Ireland: 500 – 750 metric tons • France: ca. 90 metric tons (van der Meeren & Agnalt 2000)

Table 3. Specification key, based on morphological details from Holthuis (1991), S. Lovewell (CEFAS, Lowestoft, UK) and IMR, Norway

	European lobster, *Homarus gammarus*	**American lobster,** *Homarus americanus*
Colour:	Black to light blue, violet, brown, grey, pink and white occur (Holthuis 1991)	Dark greenish brown Red and reddish tint occur (Holthuis 1991)
Colourations:	White marked spots along the frontal edge of carapace, below the eyes, cheeks and claw spines (Holthuis 1991)	No white spots or tags (Holthuis 1991)
	White marbled patterns along the side of carapace (Holthuis 1991)	No marbled patterns (Holthuis 1991)
	Reddish/orange tint on legs Holthuis 1991)	Greenish tint on legs (Holthuis 1991)
Crusher claw	Moderate rounded crusher claw (CEFAS, UK)	Well rounded crusher claw (CEFAS, UK)
Scissor claw	Sharp points inside claw make a saw-shaped impression in single line (CEFAS, UK)	Sharp points inside claw is both saw-shaped and occasionally needle like, in multiple rows (CEFAS, UK)
Rostrum:	No tags on the ventral side (Holthuis 1991) Be ware of physical damage of the rostrum	Usually one or more tags on the ventral side Holthuis 1991) Be ware of physical damage of the rostrum
Carapace:	Fairly slender, longer compared to tail length (CEFAS, UK)	Stout impression, shorter compared to tail length (CEFAS, UK)
Tail:		Generally wider tails in adult females? (IMR, Norway)

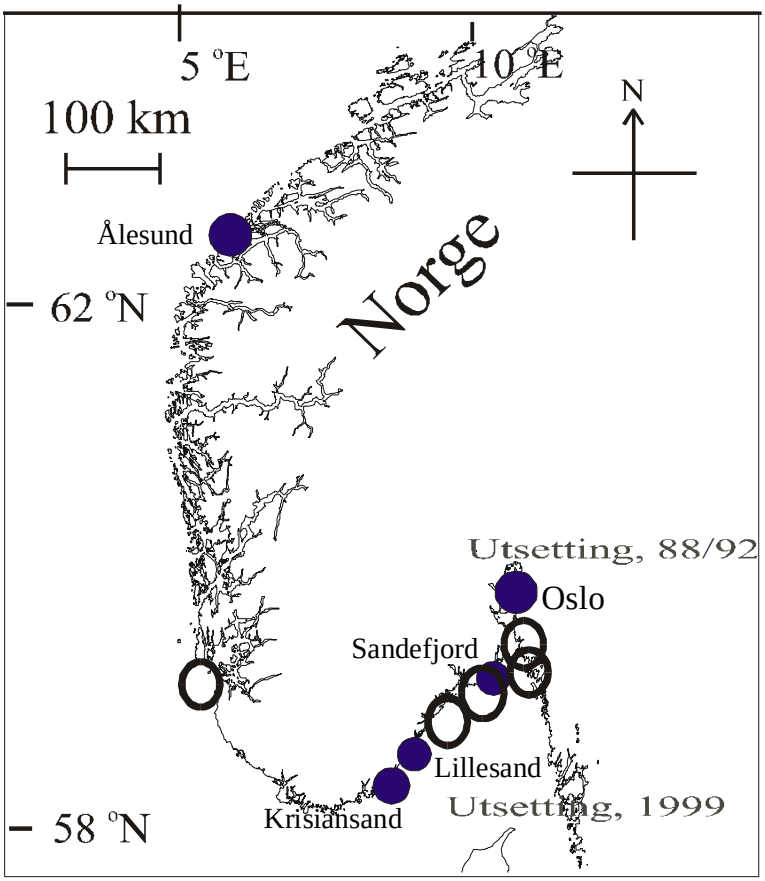


Figure 1. Map, showing the landing sites of American lobsters in Norway. Filled circles are confirmed registrations. Open circles is lobsters with some morphological traits comparable with an American lobsters, but not verified through the genetic analyses. (Translation: Norge= Norway, Utsetting= Release)

Figure 2a. Head of an American lobster caught in the Oslofjorden, Norway in 1999. ((#2 in Table 1) (Photo Kees O. Ekeli, Bergen Aquarium).

Figure 2b Head of an European lobster caught at Austevoll, Norway (Photo per Jensen, IMR).

Figure 2c) Normal patterns and coloration in American lobster and European lobster.


Photo: Kees O. Ekeli, Bergen Aquarium

c) Homarus americanus, (individual # 2, on exhibition in Bergen Aquarium): greenish brown with no distinct white markings.


Photo: Kees O. Ekeli, Bergen Aquaium

d) Homarus gammarus, (locally caught individual, on exhibition in Bergen Aquarium): black with white spots on carapace behind the mouth and eyes, white points along the upper rim of the claws, whitish inside claws and marbled in white along edges on the exoskeleton.

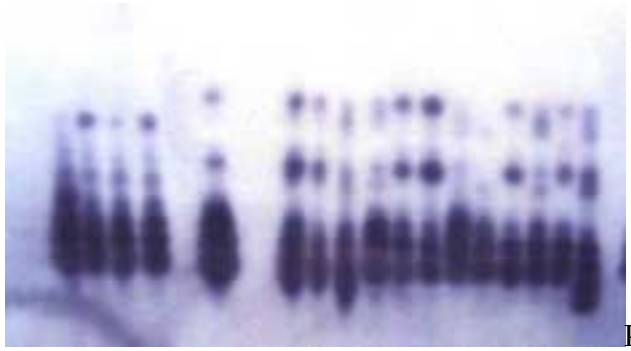


Photo: E. Farestveit, IMR

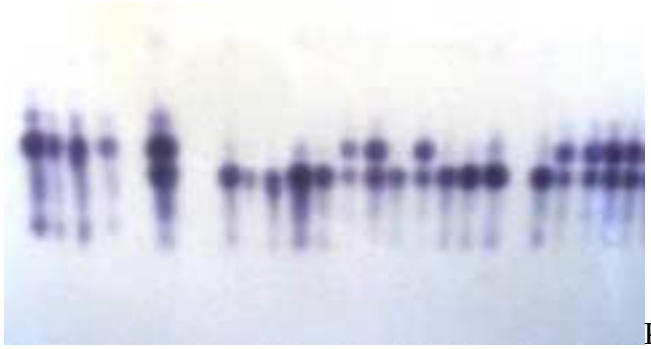
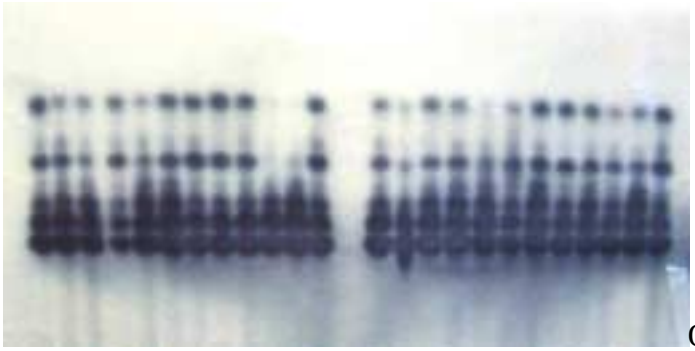


Photo: E. Farestveit, IMR

Figure 3a Example of new alleles drawn from tissue sample from one specimen was analysed by starch gel. Comparison of the enzyme system GPI (upper gel) and PGM (lower gel), in four *H. gammarus* from Norway (left), individual # 2 (single) and 12 imported *H. americanus* (right).



Ohoto: E. Farestveit, IMR

Photo: E. Farestveit, IMR

Figure 3b Example of alleles drawn from European lobster with origin in the same area: The enzyme system GPI (upper gel) and PGM (lower gel), in 24 *H. gammarus* from the Oslo fjord.