

Mud crab aquaculture

A practical manual



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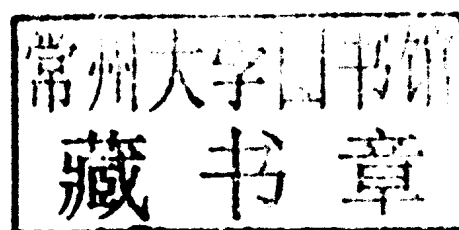
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Preparation of this document

While mud crab farming based on collection of crablets or crabs from the wild for fattening or grow-out has probably taken place for hundreds of years, hatchery production of mud crabs is a relatively recent innovation, with most research and development taking place over the last few decades.

This manual attempts to showcase the current wisdom on mud crab farming from key nations in the Asia-Pacific region where research and development, significant industry development and extension of technology have occurred in recent years.

The development of this manual reflects contributions from all major organizations and research teams involved in mud crab culture development. Attendance at numerous workshops and conferences on crab fisheries and aquaculture over the past couple of decades has provided inspiration and insight into the need for a manual such as this, one that brings together the whole process of mud crab farming from broodstock to high-quality product leaving the farm.

This manual has benefited from so many farmers, scientists, fisheries professionals, business owners, information specialists and technicians who have been kind enough to share their knowledge and skills, that to name a few might devalue the contribution of others – so to you all, thank you.

The support, patience and enthusiasm of Alessandro Lovatelli, FAO Aquaculture Officer, was critical to the completion of this publication.

Abstract

There are four species of mud crab, *Scylla serrata*, *S. tranquebarica*, *S. paramamosain* and *S. olivacea* that are the focus of both commercial fisheries and aquaculture production throughout their distribution. They are among the most valuable crab species in the world, with the bulk of their commercial production sent live to market. This is the first FAO aquaculture manual on this genus, covering everything from its basic biology and aquaculture production, through to stock packaging and being ready to go to market.

Information on mud crab biology, hatchery and nursery technology, grow-out systems, disease control, processing and packaging has been collated in this manual to provide a holistic approach to mud crab aquaculture production. Compared with other types of aquaculture, mud crab culture still has a large number of variants, including: the use of seedstock collected from the wild, as well as produced from a hatchery; farming systems that range from very extensive to intensive, monoculture to polyculture; and farm sites that vary from mangrove forests to well-constructed aquaculture ponds or fattening cages. As such, there is no one way to farm mud crabs, but techniques, technologies and principles have been developed that can be adapted to meet the specific needs of farmers and governments wishing to develop mud crab aquaculture businesses.

Each of the four species of *Scylla* has subtly different biology, which equates to variations in optimal aquaculture production techniques. Where known and documented, variants have been identified, where not, farmers, researchers and extension officers alike may have to adapt results from other species to their mud crab species of choice and local climatic variables. Compared with many other species that are the subject of industrial scale aquaculture, mud crabs can still be considered to be at an early stage of development, as the use of formulated feeds for them is still in its infancy and little work has yet been undertaken to improve stock performance through breeding programmes.

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Abbreviations, acronyms and conversions

BCD	bitter crab disease
Code	Code of Conduct for Responsible Fisheries
CUC	commercially unsuitable crab
CW	carapace width
DAC	Darwin Aquaculture Centre (Australia)
DHA	docosahexaenoic acid
DNA	deoxyribonucleic acid
EPA	eicosapentaenoic acid
FCR	feed conversion ratio
HACCP	Hazard Analysis and Critical Control Point (system)
HAT	highest astronomical tide
HUFA	highly unsaturated fatty acid
IFAT	Indirect Fluorescent Antibody Technique
LWS	low water of spring tides
MCRV	mud crab reovirus
OTC	oxytetracycline
PCD	pink crab disease
PCR	polymerase chain reaction
RNA	ribonucleic acid
rRNA	ribosomal RNA
SEAFDEC	Southeast Asian Fisheries Development Center
TAN	total ammonia nitrogen
TSV	Taura syndrome virus
UV	ultraviolet
WIO	Western Indian Ocean
WSSV	white spot syndrome virus

Not all of the following abbreviations have been used in this manual. However, they are provided as reference when reading other documents.

<	less than
>	greater than
n.a.	not analyzed or not available (also written as N/A)
µm	micron
mm	millimetre
cm	centimetre
m	metre
km	kilometre
inch	inch
ft	foot
yd	yard
mi	mile
ft ²	square foot
yd ²	square yard
mi ²	square mile

m ²	square metre
ha	hectare
km ²	square kilometre
cc	cubic centimetre (= ml)
m ³	cubic metre
ft ³	cubic foot
yd ³	cubic yard
µl	microlitre
ml	millilitre (= cc)
l	litre
µg	microgram
mg	milligram (milligramme)
g	gram (gramme)
kg	kilogram (kilogramme)
mt	metric tonne (1 000 kg) (also written as tonne)
oz	ounce
lb	pound
cwt	hundredweight [value differs in UK ('Imperial') and US units - see weight conversions]
t	ton [value differs in UK ('Imperial') and US units - see weight conversions]
psi	pounds per square inch
psu	practical salinity units
gpm	('Imperial' = UK) gallons per minute
mgd	million ('Imperial' = UK) gallons per day
cfm	cubic feet per minute
ppt	parts per thousand (also written as ‰)
ppm	parts per million
ppb	parts per billion (thousand million)
min	minute
hr	hour
kWhr	kilowatt-hour

CONVERSIONS

Please note that the words gallon and tonne have different values depending on whether the source of the text you are reading is 'British' or 'American' in origin.

Length:

1 µm	0.001 mm = 0.000001 m
1 mm	0.001 m = 1 000 µm = 0.0394 inch
1 cm	0.01 m = 10 mm = 0.394 inch
1 m	1 000 000 µm = 1 000 mm = 100 cm = 0.001 km = 39.4 inch = 3.28 ft = 1.093 yd
1 km	1 000 m = 1 093 yd= 0.621 mi
1 inch	25.38 mm = 2.54 cm
1 ft	12 inch = 0.305 m
1 yd	3 ft = 0.914 m
1 mi	1 760 yd = 1.609 km

Weight:

1 μg	0.001 mg = 0.000001 g
1 mg	0.001 g = 1 000 μg
1 g	1 000 000 μg = 1 000 mg = 0.001 kg = 0.0353 oz
1 kg	1 000 g = 2.205 lb
1 mt (or tonne)	1 000 kg = 1 000 000 g = 0.9842 UK t = 1.102 US t
1 oz	28.349 g
1 lb	16 oz = 453.59 g
1 UK cwt	112 lb = 50.80 kg
1 US cwt	100 lb = 45.36 kg
1 UK t	20 UK cwt = 2 240 lb
1 US t	20 US cwt = 2 000 lb
1 UK t	1.016 mt = 1.12 US t

Volume:

1 μl	0.001 ml = 0.000001 litre
1 ml	0.001 litre = 1 000 μl = 1 cc
1 litre	1 000 000 μl = 1 000 ml = 0.220 UK gallon = 0.264 US gallon
1 m ³	1 000 litres = 35.315 ft ³ = 1.308 yd ³ = 219.97 UK gallons = 264.16 US gallons
1 ft ³	0.02832 m ³ = 6.229 UK gallons = 28.316 litres
1 UK gallon	4.546 litres = 1.2009 US gallons
1 US gallon	3.785 litres = 0.833 UK gallon
1 mgd	694.44 gpm = 3.157 m ³ /min = 3 157 litres/min

Concentration – dissolving solids in liquids:

1 %	1 g in 100 ml
1 ppt	1 g in 1 000 ml = 1 g in 1 litre = 1 g/litre = 0.1%
1 ppm	1 g in 1 000 000 ml = 1 g in 1 000 litres = 1 mg/litre = 1 $\mu\text{g/g}$
1 ppb	1 g in 1 000 000 000 ml = 1 g in 1 000 000 litres = 0.001 ppm = 0.001 mg/litre

Concentration – dilution of liquids in liquids:

1 %	1 ml in 100 ml
1 ppt	1 ml in 1 000 ml = 1 ml in 1 l = 1 ml/l = 0.1%
1 ppm	1 ml in 1 000 000 ml = 1 ml in 1 000 l = 1 $\mu\text{l/l}$
1 ppb	1 ml in 1 000 000 000 ml = 1 ml in 1 000 000 l = 0.001 ppm = 0.001 ml/l

Area:

1 m ²	10.764 ft ² = 1.196 yd ²
1 ha	10 000 m ² = 100 ares = 2.471 acres
1 km ²	100 ha = 0.386 mi ²
1 ft ²	0.0929 m ²
1 yd ²	9 ft ² = 0.836 m ²
1 acre	4 840 yd ² = 0.405 ha
1 mi ²	640 acres = 2.59 km ²

Temperature:

°F	$(9 \div 5 \times ^\circ\text{C}) + 32$
°C	$(^\circ\text{F} - 32) \times 5 \div 9$

Pressure:

1 psi	70.307 g/cm ²
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SCIENTIFIC UNITS

Scientists have a different way of writing some of the units described in this glossary. They use what is called the *Système International* (SI). The units are referred to as SI units. For example: 1 ppt, which can be written as 1 g/litre (see concentration above) is written as 1 g litre⁻¹ in scientific journals; 1 g/kg is written as 1 g kg⁻¹; 12 mg/kg would be written as 12 mg kg⁻¹; 95 µg/kg would be written as 95 µg kg⁻¹. A stocking density of 11 kg/m³ would be written as 11 kg m⁻³. More information about this topic can be found on the Internet by searching for SI units.

Glossary

Antennae	Pair of thin sensory appendages found on the head of crustaceans.
Autotomy	The spontaneous casting off a limb or other body part by an animal when injured or to facilitate escape when under attack.
Berried	Or bearing eggs. In larger crustaceans (e.g. lobsters, crabs), a term, which is used to describe those females with large egg masses attached under the abdomen during the period of incubation.
Biosecurity	Procedures to protect animals or humans against disease or harmful biological agents.
Brackish water	Water with a salinity intermediate between seawater and freshwater, usually showing wide salinity fluctuations. Brackish water is commonly found in estuaries.
Broodstock	Mud crabs of both sexes maintained for controlled breeding purposes.
Burrowing	Making a hole or tunnel.
Cannibalism	Intraspecific predation. Eating flesh of its own species.
Carapace	The protective shell of crabs also known as exoskeleton.
Cellular systems	Culture systems constructed of individual cells.
Chela	The pincer-like claw of a crab or other crustacean.
Conditioning	Train or condition something to behave in a particular way or to improve its condition, e.g. nutrition.
Copulation	Or mating. Pairing animals for breeding purposes.
Crablets	Juvenile, post-larval mud crabs that have yet to obtain sexual maturity, subadults.
Dactyl	The claw or terminal joint of a leg of a crustacean.
Empty crab	A crab that has recently moulted (see moult), with high water content and low meat yield.
Fattening	Intensive feeding to raise the farmed animal to market size.
Feed conversion ratio (FCR)	The ratio of the gain in the wet body weight of the animal to the amount of feed fed.

Fungus	Any of a group of primitive saprophytic and parasitic spore-producing eukaryotic typically filamentous plants that lack chlorophyll and include molds, rusts, mildews, smuts, mushrooms and yeasts.
Haemolymph	The invertebrate equivalent of blood in the circulatory system.
Hatchery	A system and/or building where mud crabs are reared through their larval stages.
Hatching	The breaking of eggs and release of larvae.
Incubation	The process of incubating eggs, i.e. the period during which embryos develop inside the eggs. In mud crabs the eggs are incubated between spawning as a large egg mass, also known as “sponge”, attached under the abdomen of females.
Intertidal	The area between high and low tides; also known as the foreshore and seashore and sometimes referred to as the littoral zone.
Intermoult	The period between the moulting of crabs or description of a stage of the moult cycle.
Larvae	Or the planktonic immature phase of mud crabs. An organism from the beginning of exogenous feeding to metamorphosis into juvenile. At the larval stage the animal differs greatly in appearance and behaviour from a juvenile or an adult.
Maggots	A non-technical term to describe the larvae of flies.
Mangroves	A tidal salt marsh (intertidal) community dominated by trees and shrubs, particularly of the genus <i>Rhizophora</i> , many of which produce adventitious aerial roots. Develops in tropical and subtropical areas, in predominantly muddy or sandy substrates, and along protected coastlines.
Megalopa	The final larval stage of mud crabs, prior to their settlement to the benthic phase of their life cycle.
Metamorphosis	The process of changing shape or structure in the transition of one developmental stage into another or from an immature form to a mature form in two or more stages.
Microalgae	Microscopic algae typically found in fresh and marine waters.
Monoculture	A single species grown on its own.
Moult	Common name for the exuvium, i.e. the shed of the old exoskeleton to make way for a new layer. To moult: process of shedding the exoskeleton.

Nursery	A system or facility where post-larval mud crabs or crablets are reared to a size suitable for stocking in grow-out pond or other rearing units.
Ovary	The female reproductive organ of mud crabs.
Ozone treatment	Ozone used as an oxidizing agent to sterilize water.
Pathogens	A bacterium, virus or other microscopic organism that can cause disease in its animal or plant host.
Pens	Simple structures to contain mud crab stock for grow-out.
Phototactic	Demonstrates a positive movement toward light.
Polyculture	The rearing of two or more non-competitive species in the same culture unit.
Prophylaxis	Action taken to prevent disease by specific means or against a specific disease.
Quarantine	A state, place or period of isolation in which animals have arrived from elsewhere as they may have been exposed to disease.
Salinity	An expression for the concentration of soluble mineral salts and chlorides in water; usually expressed as parts per thousand (ppt).
<i>Scylla</i>	The scientific genus that mud crab species belong to.
Silviculture	The growing and cultivation of trees.
Spawning migration	A migration of female crabs from their usual habitat to another habitat for the purpose of spawning and hatching their eggs.
Sponge	The egg mass of female crabs held externally under their abdomens.
Subtidal	The shallow marine or tidal flat environment that is below the mean low water level of spring tides.
UV (Ultraviolet sterilization)	Ultraviolet radiation utilized to sterilize water.
Water crab or water bag	A crab that has recently moulted and typically has a high water content but low meat yield.
Zoea	The early larval stage of mud crabs.
Zooplankton	Plankton consisting of small animals and the immature stages of larger animals.

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