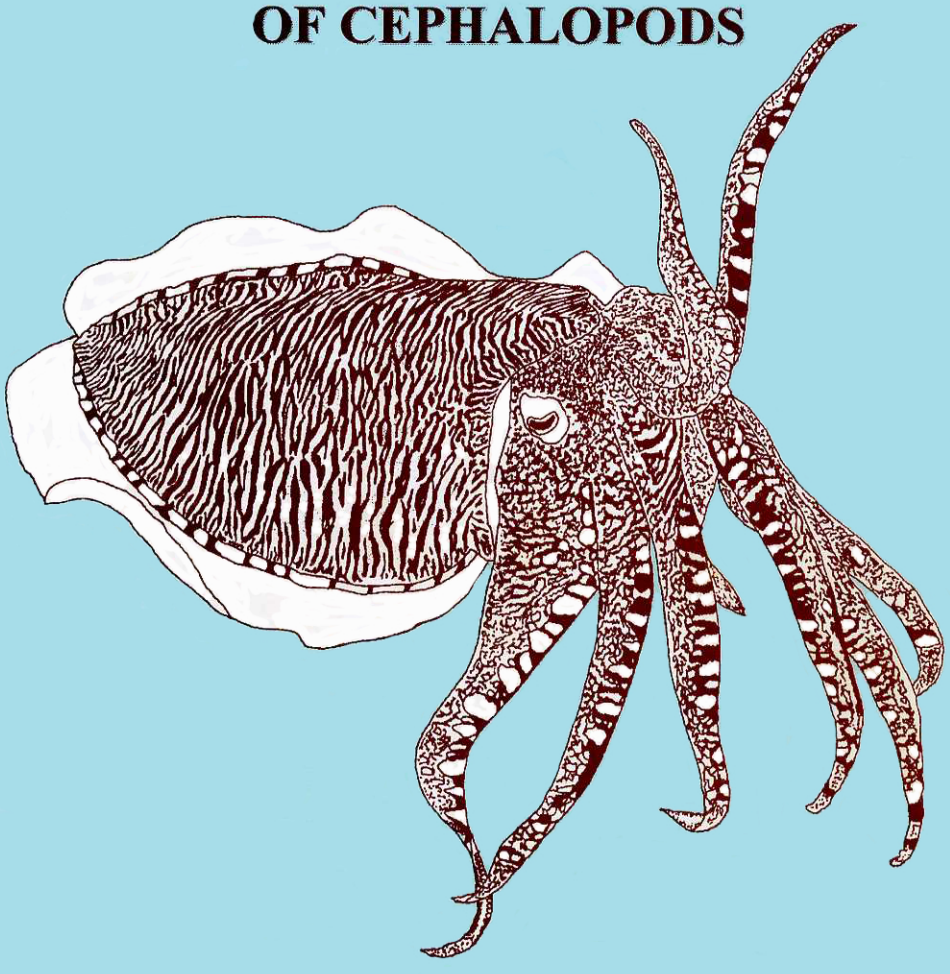
# BIOLOGY, RECRUITMENT & CULTURE OF CEPHALOPODS



# CIAC 2003

## Programme and Abstracts

Under the Auspices of :

**Cephalopod International Advisory Council (CIAC)**
**Department of Fisheries**
**Department of Marine and Coastal Resources**

*17-21 February 2003*
*PHUKET, THAILAND*

*CIAC 2003*

# BIOLOGY, RECRUITMENT & CULTURE OF CEPHALOPODS

**The International Workshop and Symposium of Cephalopod International Advisory Council (CIAC)**

*Metropole Hotel, Phuket, Thailand*
*17-21 February 2003*

Under the Auspices of :
**Cephalopod International Advisory Council (CIAC)**

**Department of Fisheries**
**Ministry of Agriculture and Cooperatives**

**Department of Marine and Coastal Resources**
**Ministry of Natural Resources and Environment**

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# WORKSHOP

## Sunday 16 February 2003

1400-2000 **Workshop-Symposium Registration**
Pra Pitak Grand Ballroom, 3rd floor,
The Metropole Hotel Phuket, Montri Rd., Phuket

## Monday 17 - Tuesday 18 February 2003

0800-0830 All Workshop participants meet at the front reception of the Metropole Hotel.
0830-0900 Leaving the hotel for the Workshop venues
0900-1200 Workshop
1200-1300 Lunch
1300-1630 Workshop
1630-1700 Back to the Metropole Hotel.

***Workshop I:***
***Developing Standard for Modelling and Describing Cephalopod Growth***

**Convenor:** Dr. Ronald K. O'Dor
**Rapporteur:** Dr. Alexander I. Arkhipkin
Dr. George D. Jackson
**Coordinators:** Ms. Atchara Vibhasiri
Ms. Praulai Nootmorn
**Place:** Phuket Marine Biological Center

**Presentation:**
"Asymptotic versus non-asymptotic:
which type of growth is characteristic for squid?"
**Alexander I. Arkhipkin**

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***Workshop II:***
***Systematics of Indo-West Pacific Octopods***

**Convenor:** Dr. Frederick G. Hochberg
**Rapporteur:** Dr. Christine L. Huffard
**Coordinators:** Dr. Anuwat Nateewathana
Ms. Vararin Vongpanich
**Place:** Phuket Marine Biological Center

**Presentation:**
"Re-evaluation of the type material of *Pareledone polymorpha* (Robson 1930): placement in a new genus and description of a new species"
**-Louise Allcock and Frederick G. Hochberg**

"A shallow water octopus species of the subgenus *Abdopus* (Cephalopoda: Octopodidae) found in Okinawa, Japan"
**-Natsumi Kaneko**

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***Workshop III:***
***Idiosepius : Ecology, Biology and Biogeography of a Mini Maximalist***

**Convenor:** Dr. Sigurd von Boletzky
**Rapporteur:** Dr. Michele K. Nishiguchi
**Coordinators:** Dr. Jaruwat Nabhitabhata
Ms. Jintana Nugranad
**Place:** Phuket Marine Biological Center

**Presentation:**
"Life history traits of the temperate mini-maximalist *Idiosepius notoides*"
**-Sean R. Tracey**, Mike A. Steer and Gretta T. Pecl

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***Workshop IV:***
***Systematics of Indo-West Pacific Loliginids***

**Convenor:** Dr Michael Vecchione
**Rapporteur:** Dr. Elizabeth K. Shea
**Coordinator:** Dr. Cherdchinda Chotiyaputta
Mr. Somchai Bussarawit
**Place:** Phuket Marine Biological Center

**Presentation:**
"A sight on a system and phylogeny of myopsid squids"
**-Dmitry Alexeyev**

"A new family of myopsid squid from Australasian waters
(Cephalopoda: Teuthida)"
**-Chung-Cheng Lu**

"Description of a new species of *Uroteuthis (Photololigo)*
from the Mozambique channel"
**-Martina A.C. Roeleveld** and C. Johann Augustyn

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# SYMPOSIUM

## Tuesday 18 February 2003

1300-1800 ***Registration*** *at symposium venue, Pra Pitak Grand Ballroom, 3rd floor, Metropole Hotel Phuket, Montri Rd. Phuket.*

1800-2100 *Informal welcoming reception*

## Wednesday 19 February 2003

0800-0900 ***Registration***

0900-0930 ***Symposium opening ceremonies***
0930-1000 ***Group photograph*** *& Coffee*

1000-1015 ***Conference Introduction***
**-Cherdchinda Chotiyaputta**

1015-1030 ***CIAC Introduction and Symposium Introduction***
**-Chung-Cheng Lu**

1030-1110 **Keynote:** "Tributes to Kir N. Nesis, A Great Teuthologist"
**Chingis Nigmatullin, Frederick G. Hochberg, Clyde F. E. Roper, Alexander I. Arkhipkin**

### *Session I: General Biology*

1110-1115 *Convenor Introduction*
**-Clyde F. E. Roper**

1115-1135 "Feeding and digestion in squid paralarvae"
**-Erica A. G. Vidal**

1135-1155 "Mating strategies in a member of the octopus *Abdopus* sub-genus from Sulawesi Indonesia: first report of mate guarding in octopus"
**-Christine L. Huffard**

1155-1215 "First approach to the quantification of age pigment Lipofuscin in brains from *Octopus vulgaris* (Mollusca: Cephalopoda)"
**-Ignacio Sobrino** and Mario del Real

1215-1235 "Do squid make a visual language on their skin? An answer for Moynihan"
**-Jennifer A. Mather**

1235-1330 *Lunch*

## *Session I: (cont.)*

*Convenor:* **Marek Lipinski**

1330-1350 "Vertical distribution of paralarval gonatid squids in the northeast Pacific"
**-John R. Bower** and Shogo Takagi

1350-1410 "Effects of season and location on the reproductive strategy adopted by *Nototodarus gouldi* in Australian waters"
**-Belinda McGrath** and George D. Jackson

1410-1430 "Cephalopod biodiversity: the twilight zone"
**-Ian Gleadall**

1430-1450 "Odor mixture interactions in olfactory neurons of the squid *Lolliguncula brevis*"
**-Mary T. Lucero** and Jonathan Danaceau

1450-1510 "Temporal variation in the diet of the onychoteuthid *Moroteuthis ingens* at Macquarie Island assessed using fatty acid dietary tracers"
**-Katrina Phillips,** George D. Jackson and Peter Nichols

1510-1530 "Plasticity in squid growth: is it genetics or environment?"
**-Lianos Triantafillos**

1530-1550 *Coffee*

*Convenor:* **Sigurd von Boletzky**

1550-1610 "*Architeuthis* in Japanese waters"
**-Tsunemi Kubodera**

1610-1630 "Genetic divergence and geographic diversification in *Octopus* cf. *vulgaris* based on mitochondrial DNA sequences"
**-Kerstin Warnke,** Rainer Soller, Dietmar Blohm and Ulrich Saint-Paul

1630-1650 "Niche overlap in teuthophagus whales in the NE Atlantic"
**-M. Begona Santos** and Graham J. Pierce

1650-1710 "Interannual variation in life-cycle biology of *Loligo forbesi* in Scottish (UK) waters"
**-Graham J. Pierce,** Peter R. Boyle and Lee C. Hastie

1710-1730 "Squid as barometers of environmental change, life in the fast lane"
**-George D. Jackson**

1900-2300 ***Welcome dinner hosted by Department of Fisheries***

## Thursday 20 February 2003

0830-0835 *Introduction & Announcement*

0835-0915 **Keynote: "**Past, present and future studies on tropical West Pacific cephalopod diversity"
**-Takashi Okutani**

## *Session I: (cont.)*

*Convenor:* **Frederick G. Hochberg**

0915-0935 **"**Lipofuscin accumulation in cephalopods: is it a measure of octopus growth?"
**-Jayson M. Semmens**

0935-0955 "Interpreting cephalopod distribution using predators foraging data"
**-Jose C. C. Xavier,** G. A. Tarling, J. P. Croxall and Paul G. Rodhouse

0955-1015 **"**Revisiting old ideas in the light of new investigations: the evolution of bacteriogenic light organs in cephalopods"
**-Michele K. Nishiguchi** and Sigurd von Boletzky

1015-1035 "Symbiotic association between some cephalopods and the *Roseobacter* bacteria strain"
**-Delphine Pichon,** Sveva Grigioni and Renata Boucher-Rodoni

1035-1055 *Coffee*

*Convenor:* **Tsunemi Kubodera**

1055-1115 "On the confusion surrounding *Pareledone charcoti* (Joubin, 1905): cryptic speciation and endemic radiation in the southern ocean"
**-Louise Allcock**

1115-1135 "Antarctic jaws: trophic relationships between sharks and cephalopods, including giant squids, in Kerguelen waters"
**-Yves Cherel** and Guy Duhamel

1135-1155 "The gonatid squids -why do some of them become watery upon maturation?"
**-Oleg Nickolaevich Katugin**

1155-1215 "Spatial and temporal aspects of chokka squid *Loligo vulgaris reynaudii* biology on the Agulhas bank, South Africa"
**-Leonard Olyott J. H.,** Warwick H. H. Sauer and Anthony J. Booth

1215-1310 *Lunch*

## *Session II: Recruitment*

1310-1315 *Convenor Introduction*
**-Paul G. Rodhouse**

1315-1335 "Are bigger Calamary hatchlings more likely to recruit?
A study based on statolith dimensions"
**-Mike A. Steer,** Natalie A. Moltschaniwskyj, Gretta T. Pecl
and A. R. Jordan

1335-1355 "Does pycnocline depth affect the hatching success
of *Todarodes pacificus* paralarvae from pelagic egg masses?"
**-Jun Yamamoto,** Yasunori Sakurai and Tsuneo Goto

1355-1415 "Stock fluctuations of Japanese common squid (*Todarodes pacificus*)
related to the winter monsoon"
**-Yasunori Sakurai,** Jun Yamamoto, Hideki Kidokoro and Ken Mori

1415-1435 "Small-scale spatial and temporal patterns of egg production
by the temperate loliginid squid *Sepioteuthis australis*"
**-Natalie A. Moltschaniwskyj** and Gretta T. Pecl

1435-1455 "Embryonic life of the squid *Loligo vulgaris* (Cephalopoda):
a comparison between Mediterranean
and eastern Atlantic populations using statolith analysis"
**-Roger Villanueva,** Alexander I. Arkhipkin, P. Jereb,
Eugenia Lefkaditou, Marek R. Lipinski, Catalina Perales-Raya,
J. Riba and F. Rocha

1455-1515 "DNA markers indicate that the distinct spawning cohorts
of Patagonian squid (*Loligo gahi*)
do not represent genetically discrete populations"
**-Paul W. Shaw** and Alexander I. Arkhipkin

1515-1535 "Relationships between early growth variation and recruitment in English
channel and Scottish waters *Loligo forbesi*"
**-Laurence Challier**, Juliette Royer, Graham J. Pierce
and Jean-Pual Robin

1535-1600 *Coffee*

1600-1630 ***CIAC Open meeting***

1630-1830 **Poster**

## Friday 21 February 2003

0830-0835 *Introduction & Announcement*

0835-0915 **Keynote:** "In search of deep sea squids"

**-Malcolm R. Clarke**

## *Session II: (cont.)*

*Convenor:* **Martina A. C. Roeleveld**

0915-0935 "Finding Japanese common squid (*Todarodes pacificus*) migration routes in the Japan/East Sea"
**-Hidetada Kiyofuji** and Sei-ichi Saitoh

0935-0955 "Reproduction of *Octopus vulgaris* from the Saharan bank (northwest Africa)"
**-Eduardo Balguerias**

0955-1015 "Embryonic development and mortality of *Illex argentinus* as a function of temperature: a possibility of the spawning along the Malvinas current"
**-Mitsuo Sakai,** Norma E. Brunetti and Marcela Ivanovic

1015-1035 "Inter-annual changes in population structure and life-history characteristics of a temperate squid: environment or effects of fishing?"
**-Gretta T. Pecl,** Natalie A. Moltschaniwskyj, Sean R. Tracey and J. R. Jordan

1035-1055 *Coffee*

*Convenor:* **Ronald K. O'Dor**

1055-1115 "Why is the body size of the neon flying squid (*Ommastraphes bartamii*) of the autumn cohort much bigger than that of the winter-spring cohort in the north Pacific?"
**-Taro Ichii,** Kedarnath Mahapatra and Mitsuo Sakai

1115-1135 "Using Lights to track squid fishing fleets from space"
**-Claire Marie Waluda**

1135 –1155 "A model of loliginid squid survival (Cephalopoda: Loliginidae)"
**-Marek R. Lipinski,** Christian Wissel, Rene Navarro and Jose D'Olivera

1155-1215 "Could poor recruitment in the South African chokka squid fishery (*Loligo vulgaris reynaudii*) be caused by offshore losses of paralarvae?"
**-Michael Roberts**

1215-1235 "Management of the squid fishery in post apartheid South Africa"
**-Warwick H. H. Sauer** and J. Tucker

1235-1330 *Lunch*

*Convenor:* **Michael Vecchione**

1330-1350 "The chambered nautilus fishery of northwestern Panay island, west central Philippines: yield, fishing practices and seasonality"
**-Annabelle G. C. Del Norte-Campos,** Rheza A. Beldia, Marianito Bernardo and Jessy Maquirang

1350-1410 "Biology and ecology of *Photololigo etheridgei* and its application to the management of squid fisheries in NSW, Australia"
**-Katie O'Donnell**

## *Session III: Culture*

1410-1415 *Convenor Introduction*
**-Udom Bhatiyasevi**

1415-1435 "Experimental study of the effect of enriched frozen diet on digestive enzymes and growth of juvenile cuttlefish *Sepia officinalis* L. (Mollusca: Cephalopoda)"
**-Noussithe Koueta,** A. Perrin and E. Le Bihan

1435-1455 "Laboratory studies of the food selectivity and diurnal changes in feeding activity of squids and cuttlefishes"
**-Susumu Segawa** and Akira Maekawa

1455-1515 "Life cycle of cultured bobtail squid, *Euprymna hyllebergi* Nateewathana, 1997"
**-Jaruwat Nabhitabhata,** Pitiporn Nilaphat, Pichitra Promboon and Chan Jaroongpattananon

1515-1545 *Coffee*

1545-1645 ***Workshop Summaries***
1645-1715 ***CIAC Closing***

1900-2300 ***Formal Symposium banquet***

# POSTERS

"Chemical stimuli and feeding behaviour in the octopus, *Octopus vulgaris*"
**-Kazuhiko Anraku,** Miguel Vazquez Archdale and Kiyomi Hatanaka

"Spatial colonization by *Octopus vulgaris* in the Saharan bank (northwest Africa)"
**-Eduardo Balguerías**

"Cephalopods fishery of Malaysia"
**-Samsudin Basir** and Yoshikazu Nakamura

"Molecular approach of cephalopod phylogeny: the case of *Idiosepius*"
**-Laure Bonnaud,** Delphine Pichon and Renata Boucher-Rodoni

"Preliminary descriptions of gonatid paralarvae from the northeast Pacific"
**-John R. Bower,**

"Cephalopods from the Thai-Danish scientific cooperation sampling cruises in the Andaman Sea of Thailand"
**-Somchai Bussarawit** and Tsunemi Kubodera

"Lateralized eye use in *Octopus vulgaris* on the population level"
**-Ruth A. Byrne**, Michael J. Kuba and Daniela V. Meisel

"Understanding cephalopod growth: assessing protein synthesis and nitrogen-flux"
-Chris Carter and **Natalie A. Moltschaniwskyj**

"Octopus proliferations off the coast of Senegal: endogenous and exogenous factors"
**-Alain Caveriviere** and Didier Jouffre

"Recruitment spatial patterns and migratory exchange in English channel loliginid squids described with spatial cohort analysis"
-Juliette Royer**,** Graham J. Pierce and **Jean-Pual Robin**

"The influence of temperature and salinity on the statolith of the oval squid *Sepioteuthis lessoniana* during early developmental stages"
**-Wen-Sung Chung** and Chung-Cheng LU

"Range extension for two cephalopod species in the northwestern Gulf of Mexico"
**-Jennifer DeBose**

"Maturation, fecundity and seasonality of reproduction of *Euprymna stenodactyla*, Gulf of Mannar southeast coast of India"
**-Samuel V. Deepak** and Jamila Patterson

"The dynamics of benthic turbidity on the spawning grounds of chokka squid (*Loligo vulgaris reynaudii)* and links to squid catches"
**-Karen Dorfler** & Michael Roberts

“Phylum Dicyemida in Australian waters: first record and distribution
across shallow-water cephalopod hosts”
**-Julian K. Finn,** Frederick G. Hochberg and Mark D. Norman

Distribution of cephalopods in the eastern Pacific Ocean based in stomach contents
of large predators
**-Felipe Galvan-Magana** and Robert J. Olson

“Cephalopod diversity, fisheries and culture in Indonesia”
**-Abdul Ghofar**

“Examination of different preservatives for *Todarodes pacificus* paralarvae
fixed with borax-buffered formalin-seawater solution
**-Tsuneo Goto**

“Double signaling in *Sepioteuthis sepioidea*”
**-Ulrike Griebel** and Jennifer A. Mather

“The effects of temperature and acclimation on oxygen consumption
by juvenile cuttlefish, *Sepia officinalis***”**
**-Panos Grigoriou,** Christopher Richardson and Andrew Yule

“Two new species of *Sepia* (*doratosepion*)(Cephalopoda: Sepiidae) from Taiwan,
based on morphological and molecular data”
**-Chuan-Wen Ho** and Chung-Cheng Lu

“Arrow squid and the coastal ecosystem:
using acoustic technology to unravel the ecology”
**-Kate Hodgson**, George D. Jackson and Jeremy Lyle

“Examining the effect of seasonal temperature changes on octopus growth”
**-K.A. Hoyle,** Jayson M. Semmens and Gretta T. Pecl

“Morphology and possible function of caudal glands
of *Sepiella japonica* Sasaki, 1929 Sepiidae: Cephalopoda”
**-Meng-Min Hsueh** and Chung-Cheng Lu

“The effect of low temperature on the reproductive activity
of *Loligo bleekeri* Keferstein, 1866”
**-Yoko Iwata,** Kingo Ito and Yasunori Sakurai

“Species distribution and spawning grounds of cuttlefish
in the upper Gulf of Thailand”
**-Jintana Jindalikit** and Kanitha Sereeruk

Description of hatchling of Thai pygmy squid,
*Idiosepius thailandicus* Chotiyaputta, Okutani & Chaitiamvong, 1991”
**-Jutamas Jivaluk**, Jaruwat Nabhitabhata and Anuwat Nateewathana

Description of hatchling of Thai type of bigfin squid,
*Sepioteuthis lessoniana* Lesson, 1830, with note on comparison to Japanese types"
**-Jutamas Jivaluk**, Jaruwat Nabhitabhata and Anuwat Nateewathana

"The role of cannibalism in the trophic ecology and population structure
of *Illex argentinus* and *Loligo gahi*"
**-Nadine Johnston** and Pual G. Rodhouse

"Identification of gonatid squid spawning areas in the Bering Sea and Gulf of Alaska based on paralarval distribution, with comments on paralarval taxonomy"
**-Elaina M. Jorgensen**

"Combining fishing closure with minimal size of capture to improve
octopus production in Senegalese waters: an evaluation using analytical modelling"
**-Didier Jouffre** and Alain Caveriviere

"Life cycle of the Japanese pygmy cuttlefish *Idiosepius paradoxus* (Cephalopoda: Idiosepiidae) in the *Zostera* bed at the temperate coast of central Honshu, Japan"
**-Takashi Kasugai,** and Susumu Segawa

"Cause of the change of paralarval distribution range for the Japanese common squid *Todarodes pacificus* in the Sea of Japan"
**-Hideki Kidokoro,** Tsuneo Goto and Shogo Kasahara

"Manual for the identification of cephalopod beaks in the northwestern Pacific"
**-Tsunemi Kubodera**

"Immunological and biological characterization of peptides
related to the calcitonin gene in the cuttlefish *Sepia officinalis*."
**-Anne-Gaëlle Lafont,** Martine Fouchereau-Peron, Sylvie Dufour
and Renata Boucher-Rodoni

"Morphological changes at maturation and systematics
in the squid genus *Alloteuthis*"
**-Vladimir Laptikhovsky,** Alp Salman, Bahadir Önsoy and Hassan Moustahfıd

"Juvenile planktonic cephalopods sampled off the coasts of central Greece (eastern Mediterranean) during winter"
**-Eugenia Lefkaditou,** Apostolis Siapatis and Athanasios Machias

"A new family of myopsid squid from Australasian waters (Cephalopoda: Teuthida)"
**-Chung-Cheng Lu**

"Pushing the limits of multiple spawning: muscle tissue dynamics
of a multiple spawning ommastrephid squid *Nototodarus gouldi*."
**-Belinda McGrath**

"The environmental influence on early growth of squid
from statolith increment measurements"
**-Ana Moreno** and Manuela Azevedo

“Performance of simple large-scale cephalopod culture system in Thailand”
-Jaruwat Nabhitabhata**, Pitiporn Nilaphat**, Pichitra Promboon,
Chan Jaroongpattananon, Gaysorn Nilaphat and Anuwat Reunreng

“Pygmy cuttlefish *Idiosepius paradoxus* (Ortmann, 1888) (Cephalopoda)
-first record of Idiosepiidae in Russian seas”
-Kir N. Nesis**, Oleg Nickolaevich Katugin** and A.V. Ratnikov

“Species diversity, abundance and community structure of cephalopods
off Phang-nga Bay and adjacent area, Thailand”
**-Praulai Nootmorn**, Sichon Hoimuk, Durongrit Keawkaew
and Wanlee Singtongyam

“Species diversity, abundance and community structure of cephalopods
off upper part of Andaman coast, Thailand”
**-Praulai Nootmorn**, Sichon Hoimuk and Udomsin Augsornpa-ob

“The cephalopod mantle as an energy store:
using the ‘min-maximalist’ *Idiosepius* as a model”
**-Gretta T. Pecl,** and Natalie A. Moltschaniwskyj

“Non-conventional method to improve estimation of LPUE
from artisanal octopus fisheries in Portugal.”
**-João M.F. Pereira**

“Distribution of some cephalopod species
along the Catalan coast (NW Mediterranean)”
**-Juan Pablo Pertierra** and Pilar Sanchez

“Growth of the north Pacific giant *Entroctopus dofleini*”
**-P. Robin Rigby** and Yasunori Sakurai

“Spatial-temporal changes in dimethyl acetal (Octadecanal) levels
of *Octopus vulgaris* (Mollusca Cephalopoda): relation to feeding ecology”
**-Rui A. Rosa,** Antonio M. Marques, M.L. Nunes, N. Bandarra and Reis C. Sousa

“Age and growth of *Ommastrephes bartrami* paralarvae in the north Pacific
with a special reference of temperature effect for the autumn cohort”
**-Mitsuo Sakai** and Taro Ichii

“Observations on possible egg masses of the squid, *Todarodes pacificus*
in the Sea of Japan”
**-Yasunori Sakurai,** Jun Yamamoto, Ryosuke Uji, Takeshi Shimura
and Shinya Masuda

“Contamination of heavy metals in cephalopods
along the eastern coast of the Gulf of Thailand during 1999-2000”
-Joompol Sanguansin**, Supawat Kan-Atireklap**, Jaruwat Nabhitabhata,
Suthida Kan-Artireklap and Sompong Buntivivatkul

“Squid prey of salmon in the northeast Pacific”
**-Yasuko Sato,** John Bower and Yasunori Sakurai

“*In situ* observations of egg-brooding in *Gonatus onyx* (Cephalopoda: Gonatidae)
in the deep Monterey canyon”
**-Brad Seibel**

“Bioaccumulation of lead in *Octopus vulgaris* tissues
along the year in Cascais (Portugal)”
**-Sonia I.F. Seixas**

“Movement of *Octopus maorum* in relation to the unique Eagle Hawk Bay fishery”
**-Jayson M. Semmens**

“The biology of the musky octopus *Eledone moschata* (Lamarck, 1799)
off the south coast of Portugal”
**-João Sendão,** Ana Dinis and Teresa Cerveira Borges

“The cephalopods of the south coast of Portugal”
**-João Sendão** and Teresa Cerveira Borges

“Gross morphology of the tentacular ontogeny
in three species of ommastrephid paralarvae”
**-Elizabeth K. Shea**

“Embryonic brain development of the loliginids: axonal scaffold, neuropil formation,
and correlation with the early life styles”
**-Shuichi Shigeno** and Masamichi Yamamoto

“Possible spawning by the squid *Todarodes pacificus* at Yamato Rise
in the Sea of Japan”
**-Tsuyoshi Shimura,** Jun Yamamoto, Yoshihiko Kamei and Yasunori Sakurai

“Context-specific behavioural individuality in a sepiolid squid
(*Euprymna tasmanica*) and correlates of individuality and squid condition”
**-David Sinn** and Natalie A. Moltschaniwskyj

“Exploration of purpleback flying squid, *Sthenoteuthis oualaniensis* resources
in the waters of Southeast Asian region”
**-Somboon Siriraksophon**

“Metabolic profile and odor responsiveness
of squid olfactory neuron subtypes”
**-Arie A. Sitthichai,** W.C. Michel and Mary T. Lucero

“Squid embryo growth and survival: the role of maternal condition.”
**-Mike A. Steer** and Natalie A. Moltschaniwskyj

“Dietary effects on fatty acid and stable isotope profiles
of the brief squid *Lolliguncula brevis* -a feeding study”
**-Gabi Stowasser,** Graham J. Pierce, C.F. Moffatt, and Martin A. Collins

“Age and maturity of Japanese common squid *Todarodes pacificus*
caught by inshore fisheries of the Sea of Japan”
**-Kaori Takagi**

Nutrition value of squid “as food for human ???”
**-Supis Thongrod**, Laddawan Krongpong, Cherdchinda Chotiyaputta,
Praulai Nootmorn and Jaruwat Nabhitabhata

“Life history traits of the temperate mini-maximalist *Idiosepius notoides*”
**-Sean R. Tracey,** Mike A. Steer and Gretta T. Pecl

“Species composition and economic importance of cephalopod fisheries
in Cambodia”
**-Ing Try** and Kathe R. Jensen

“Distribution of the epipelagic cephalopods
in the waters adjacent to Okinawa Islands, Japan”
**-Kotaro Tsuchiya,** Tomoyuki Itoh and Sachiko Tsuji

“Diversity of population *Sepia pharaonis* in the Persian Gulf and Gulf of Oman”
**-Tooraj Valinassab**

“Unusual incirrate octopods from the South Shetland Islands, Antarctica,
including *Bathypurpurata profunda*, a newly discovered genus and species
of deepwater pygmy octopod (Cephalopoda)”
**-Michael Vecchione**, Louise Allcock and Uwe Piatkowski

“Development of predatory behaviour in hatchling squid:
the role of arms and tentacles”
**-Erica A. G. Vidal,** Benjamin Stafford, Paul DiMarco and Phillip G. Lee

“Post-hatching morphological changes with growth
of diamondback squid *Thysanoteuthis rhombus*”
**-Toshie Wakabayashi,** Kotaro Tsuchiya and Susumu Segawa

“A hypothesis concerning the oceanographic influence
on cuttlefish (*Sepia officinalis*) migration and abundance
in the English channel and adjacent waters”
**-Jianjun Wang,** Graham J. Pierce, Peter R. Boyle, Jose M. Bellido
and Jean-Paul Robin

“The studies of the organic matrix of cuttlebone: molecular weights,
characteristic infrared spectrum and amino acid composition”
**-Shu Xiao**, Xiaodong Zheng, Zhaoping Wang and Rucai Wang

“Age determination from gladius lamellae of reared bigfin reef squid, *Sepioteuthis lessoniana* Lesson”
**-Anyanee Yamrungrueng**, Jaruwat Nabhitabhata, Cherdchinda Chotiyaputta, Tanittha Tappanand, Taweep Boonwanit, Pichitra Promboon and Chan Jaroongpattananon

“Status of studies on cephalopod genetic diversity in China”
**-Xiaodong Zheng** and Rucai Wang

## *Thai Words for Cephalopods*

Pla Muk = cephalopods (*lit.* ink fish)
Hua = head
Kreeb = fin
Nuad = arm
Taa = eye
Parg = mouth
Poom dood = sucker
Kra-dong = cuttle bone
Pluaek = shell
Kai = egg

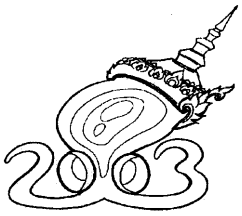
Hoy Gnuang Chang = Nautiloid (*lit.* Elephant trunk shell)

Pla Muk Kra-dong = Sepiid cuttlefish (*lit* Cuttle-bone ink fish)
Pla Muk Kra-dong Lai Sua = *Sepia pharaonis* (*lit.* Tiger cuttlefish)
Pla Muk Kra-dong Lai Parg = *S. lycidas* (*lit*. Lip cuttlefish)
Pla Muk Kra-dong Hang Laem = *S. brevimana* (*lit.* Sharp-tail cuttlefish)
Pla Muk Kra-dong Hoo = *S. arabica* (*lit.* Ear cuttlefish)
Pla Muk Kra-dong Hang Mai = *Sepiella inermis* (*lit.* Black-tail cuttlefish)
Pla Muk Hoo Chang = Sepiolid squid (*lit.* Elephant-ear ink fish)
Pla Muk Krae = Idiosepiid squid (*lit.* Pygmy ink fish)
Pla Muk Krae Thai = *Idiosepius thailandicus* (*lit.* Thai pygmy squid)

Pla Muk Kluay = Loliginid squid (*lit.* Banana ink fish)
Pla Muk Kra-toy = Loliolid squid (*lit.* Jerking ink fish)
Pla Muk Horm = *Sepioteuthis lessoniana* (*lit.* Big-banana ink fish)

Pla Muk Sai = Octopus (*lit.* String-arm ink fish)
Hoy Gnuang Chang kra-dara = Argonaut (*lit.* Paper nautiloid)
Pla Muk Sai Khao = *Cistopus indicus* (*lit.* White octopus)
Pla Muk Sai Dum = *Octopus marginatus* (*lit.* Black octopus)
Pla Muk Sai Yai = *O. aegina* (*lit.* Big octopus)
Pla Muk Sai Ra-cha = *O. rex* (*lit.* King octopus)
Pla Muk Sai Jood Khao = *O. neglectus* (*lit.* White-spot octopus)
Pla Muk Sai See Tab = *O. siamensis* (*lit.* Four-stripes octopus)
Pla Muk Sai Wong Far = *Hapalochlaena maculosa* (*lit.* Blue-ring octopus)

# ABSTRACTS



**ALEXEYEV, Dmitry**
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17V Krasnoselskaya St., Moscow, 107140, Russia

# A SIGHT ON A SYSTEM AND PHYLOGENY OF MYOPSID SQUIDS

On the base of analysis of morphology of most of recent myipsid squids a scheme of a system and phylogeny of this group is offered. All recent myopsid squids must be arranged in five subfamilies inside one family Loliginidae. Genus *Alloteuthis* has a gladius with a small but distinct rostrum. No any of another recent loliginids have a rostrum. *Alloteuthis* was separated from another loliginids rather long ago, and this group has probably a subfamiliar rank. Genera *Loligo*, *Loliolus* and *Sepioteuthis* also have many primitive features – a symmetrical hectocotylus, a wide gladius with rather well developed axial plates. These three genera must be united in subfamily Loligininae. Two much numerous and evolutionary advanced subfamilies derived from subfamily Loligininae: subfamily Lolliguncinae (genera *Lolliguncula*, *Amerigo*, *Doryteuthis*, *Loliolopsis* and *Heterololigo*) derived from primitive and nonspecialized ancient *Loliolus*-like loliginins and acquired an asymmetrical hectocotylus. Ancestors of subfamily Uroteuthinae (genera *Uroteuthis*, *Photololigo*, *Aestuariolus*(?) and *Afrololigo*) derived also from primitive loliginins. They acquired luminescent organs on an ink sac. Representatives of this subfamily have the most advanced gladius in family Loliginidae. At last a highly specialized and possibly neothenic genera *Pickfordiateuthis* derived from Lolliguncinae. It must be placed inside Loliginidae as a subfamily.

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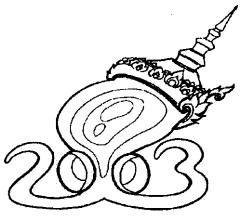


**ALLCOCK, Louise**
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# ON THE CONFUSION SURROUNDING *PARELEDONE CHARCOTI* (JOUBIN, 1905): CRYPTIC SPECIATION AND ENDEMIC RADIATION IN THE SOUTHERN OCEAN

Until recently all papillated specimens of *Pareledone* were ascribed to the species *Pareledone charcoti* (Joubin, 1905), of which *P. aurorae* (Berry, 1917) was considered a junior synonym. Re-examination of all the papillated type material of *Pareledone* coupled with extensive fishing over several years off the Antarctic Peninsula has led to a revision of this position. Seven species of papillated *Pareledone* are identified from the Peninsula region. They are identified by subtle taxonomic characters such as colour patterns and skin texture, particularly by the morphology of their papillae, although traditional indices often fail to separate the species. Although apparently sympatric, there is some evidence of niche separation of these species with respect to depth. A key is provided for their identification and data are provided illustrating their abundance and relative importance to the Antarctic benthic ecosystem.

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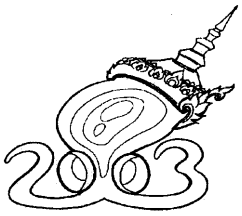

**ALLCOCK, Louise[1] and Frederick G. HOCHBERG[2]**
[1]Queen's University Belfast, 97 Lisburn Road, Belfast BT9 7BL, UK.
[2]Santa Barbara Museum of Natural History, 2559 Puesta del Sol Road, Santa Barbara, California 93105, USA.

# RE-EVALUATION OF THE TYPE MATERIAL OF *PARELEDONE POLYMORPHA* (ROBSON 1930) INCLUDING DESCRIPTION OF A NEW GENUS AND NEW SPECIES

The syntypes of *Graneledone polymorpha* Robson, 1930 were re-examined and details of measurements, counts and indices are presented. A lectotype is designated for this Antarctic species. The two forms mentioned by Robson, namely *oblonga* and *affinis*, were determined to have no taxonomic validity. The species *polymorpha* is distinct from its congener *Pareledone adeliana* (Berry, 1917) based on body proportions, sucker counts, ligula length, external colouration and size at maturity. Both species are transferred to a new genus which can be separated from the genus *Pareledone s.s* on the basis of hectocotylus morphology, beak and radula morphology, posterior salivary gland size, configuration of the funnel organ and skin sculpture. A new species is described from the Antarctic Peninsula.

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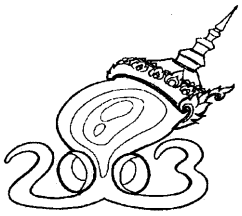


**ANRAKU, Kazuhiko, Miguel VAZQUEZ ARCHDALE and Kiyomi HATANAKA**
Faculty of Fisheries, Kagoshima University, Shimoarata 4-50-20, Kagoshima 890-0056, Japan

# CHEMICAL STIMULI AND FEEDING BEHAVIOUR IN THE OCTOPUS, *OCTOPUS VULGARIS*

The effects of chemical stimuli in the feeding behaviour of *Octopus vulgaris* were studied using pellets made from starch and cellulose (binders) and amino acids (Alanine, Proline, Methionine, Serine, Glycine, Betain), sugars (Glucose, Galactose, Saccharose), Quinine-HCl, fish extract (*Spratelloides gracilis*), or cephalopod ink (*Octopus vulgaris O. aegina* or *Sepioteuthis lessoniana*). The consumed amounts of each pellet type were used to analyze the feeding intensity for each chemical substance. *O. vulgaris* differed in behaviours depending on the pellet contents. The feeding behaviour sequence towards pellets with fish extract was (I) touch and grasp with the arm, (II) transfer to the mouth, (III) ingest. The frequencies of appearance of the consecutive behaviour from (I) to (II) were significantly high and low in fish extract and *S. lessoniana* ink respectively, when compared with the control pellet (binder). Other pellet types were transferred to the mouth as frequent as the control pellet. From stages (II) to (III), only the fish extract was highly ingested, while Met, Gly, Gal and *O. aegina* ink were consumed less than the control. It is suggested that the chemoreception properties of the arms and lips may be different and also that tactile stimuli strongly affects the feeding behaviour.

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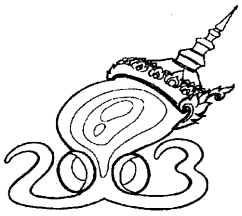


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# ASYMTOTIC VERSUS NON-ASYMTOTIC: WHICH TYPE OF GROWTH IS CHARACTERISTIC FOR SQUID?

During the last few decades, a big argument has been existing among researchers investigating the squid growth. Some of them claim that squid are characterised by the non-asymptotic growth, growing either exponentially or logarithmically until the end of the life. Others consider that at least some squid grow with asymptotically decreasing growth rates by the end of their ontogenesis. To solve this problem, indices of various parts of the reproductive system, digestive gland and mantle with fins were investigated throughout the life cycle of various shelf and pelagic squid. It was revealed that the type of growth depends on several parameters which determine the life cycle strategy of squid, namely the proportion of both mature and spent period in the squid life, type of spawning (short massive or prolong intermittent) and the degree of development of the energy storage organ for the reproductive growth (digestive gland and/or mantle). Depending on combination of these parameters, squid grow either non-asymptotically (mainly shelf myopsid species) or asymptotically (mainly oceanic oegopsid species). Possible evolutionary trends in developing different types of squid growth were suggested.

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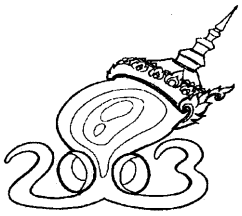

**BALGUERÍAS, Eduardo**
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# REPRODUCTION OF *OCTOPUS VULGARIS* FROM THE SAHARAN BANK (NORTHWEST AFRICA)

*Octopus vulgaris* Cuvier, 1797 is the most abundant and ubiquitous cephalopod species occurring in the Saharan Bank (Northwest Africa between 21ºN and 26ºN). Its life cycle has been described in several papers mostly published in the grey literature. Among them there are some partially dealing with reproductive aspects of the species in the region. This paper revisits the subject in light of new data and findings gathered in the most recent years. It provides information on sex-ratio, length and weight at first maturity, spawning seasons, recruitment processes and biometry of reproductive systems in relation to spatial and temporal dimensions.

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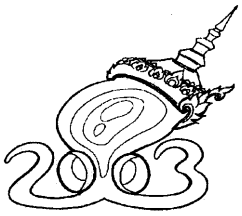

**BALGUERÍAS, Eduardo**
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Carretera de San Andrés 45, 38120 Santa Cruz de Tenerife, Spain

# SPATIAL COLONIZATION BY *OCTOPUS VULGARIS* IN THE SAHARAN BANK (NORTHWEST AFRICA)

Several authors have suggested that the apparent increase of *Octopus vulgaris* Cuvier, 1797 population in the Saharan Bank (Northwest Africa between 21ºN and 26ºN) was due to the overexploitation of finfish occurring in the region. This hypothesis has not been proved although there are signs indicating temporal changes in the benthic community that may be a consequence of both natural processes and human disturbances in the ecosystem. These circumstances seem have favoured the emergence of optimal habitats allowing the geographical expansion of octopus in the region. Information collected in the course of a series of research surveys and scientific observations onboard commercial vessels carried out in the Saharan Bank since 1941 has permitted to document this seabed colonization by octopus. Spatial analyses on occurrence and density data across the years show the evolution of the process.

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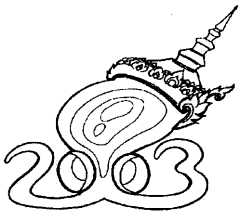


**BASIR, Samsudin[1] and Yoshikazu NAKAMURA [2]**
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# CEPHALOPODS FISHERY OF MALAYSIA

Statistical data obtained from the Department of Fisheries, Malaysia and Malaysian Fisheries Development Authority from year 1971 – 1999 and the data from several demersal fisheries survey results were analyzed to provide an overview of the cephalopod fisheries in Malaysia. The data were summarized into landing by month, fishing gear, fishing effort and fishing area. The annual trend of cephalopod showed the increase in landing. The trawl fishery accounts 95% of the cephalopod landings and other artisanal gears contributing to the landings are traps, hook and line, cash net and a few from purse seine net. The west coast of Peninsular Malaysia records the highest landings of the cephalopod and squids make up 95% of the total cephalopod landing. Average monthly landings from the last 10 years shows the squid season to occur during early of the year and in September. The most abundance squid species in the west coast (Strait of Malacca) and east coast (South China Sea) of Peninsular Malaysia are *Loligo duvaucelli* and *Loligo chinensis* respectively. The trawler of the size greater than 40 GRT shows higher CPUE (kg/boat/day).

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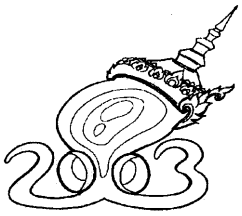

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# MOLECULAR APPROACH OF CEPHALOPOD PHYLOGENY: THE CASE OF *IDIOSEPIUS*

The number of tools are increasing in cephalopod taxonomic and phylogenetic studies. Adding to morphological and histological characters, molecular characters by gene sequence analysis are now usable at different levels: first by using partial genome of the species of interest and second and it is an indirect approach through symbiotic organisms study i.e. coevolution processes. *Idiosepius* is a case where molecular analyses have allowed to reevaluate the taxonomic and phylogenetic position. We reconsider and discuss the contribution of molecular sequences to this specific taxonomic problem: is *Idiosepius* definitely not a sepiolid?

As most sepioids and myopsids, *Idiosepius* harbours symbiotic bacteria in the accessory nidamental glands and the bacteria strains present in *Idiosepius pygmeus* glands are compared to those of Sepiolids, Sepiids and Myopsids in order to further analyse the position of *Idiosepius* within the group.

The perspective in an evolutionary context (the third molecular approach) should be the analysis of the differences in the molecular mechanisms of recognition and/or transmission that explain the variation between the different taxa and the phylogenetic relationships.

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# PRELIMINARY DESCRIPTIONS OF GONATID PARALARVAE FROM THE NORTHEAST PACIFIC

Gonatid paralarvae are difficult to identify due to poorly understood taxonomy (the paralarval stages from 7 of the 16 known gonatid species in the North Pacific remain undescribed). The lone key published for gonatid paralarvae in the North Pacific describes the external characteristics of specimens larger than 5 mm mantle length, however most gonatids collected in paralarval surveys are smaller than this size. The present study provides preliminary descriptions of these small stages for several gonatid taxa from the Northeast Pacific.

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# VERTICAL DISTRIBUTION OF PARALARVAL GONATID SQUIDS IN THE NORTHEAST PACIFIC

The vertical distribution patterns of several abundant cephalopod taxa were examined from depth-stratified tows in the northeast Pacific during three summer surveys in 1999-2001. A total of 309 cephalopods representing 10 taxa in 3 families were collected. Gonatid squids composed 97% of the total catch, and the most numerous taxa were *Berryteuthis anonychus* (59% of the total catch), *Gonatopsis borealis* (17%) and *Gonatus* spp. (16%). *Berryteuthis anonychus* and *Gonatus* spp. were both most abundant in the upper 20 m; catches of both taxa varied significantly with depth and were significantly higher above the thermocline than in and below the thermocline. *Gonatopsis borealis* was collected mostly between 20 and 50 m, and catches were significantly higher in the thermocline than above and below the thermocline. Paralarvae of the three major taxa showed no evidence of diel vertical migration. Mantle lengths (ML) of the major taxa varied significantly with depth; each showed a pattern of increasing size with depth, and correlations between ML and depth were significant in *Gonatopsis borealis* and *Gonatus* spp. As ML increased, *B. anonychus* and *Gonatus* spp. tended to gradually descend into and below the thermocline, whereas *Gonatopsis borealis* showed the same trend but within the thermocline.

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# CEPHALOPODS FROM THE THAI-DANISH SCIENTIFIC COOPERATION SAMPLING CRUISES IN THE ANDAMAN SEA OF THAILAND

The bottom trawl survey off the Andaman Sea had been conducted by the Thai-Danish scientific cooperation project during 1996-2000 from the depth range 40-800 m including hand line fishing during offshore night floating. By the survey, 11 families 13 genera and 22 species of cephalopods were sampled and reported. They are: *Sepia (Acanthosepion) recurvirostra* (Sepiidae), *Euprymma hyllebergi* (Sepiolidae), *Loligo (Photololigo) duvauceli* (Loligonidae), *Ancistrocheirus lesueuri* (Ancistrocheiridae), *Abralia (Heterobralia) andamanica* (Enoploteuthidae), *Octopoteuthis* cf. *megaptera* (Octopoteuthidae), *Histioteuthis celetaria pacifica* (Histoteuthidae), *Sthenoteuthis oualaniensis* (Omnastrephidae), *Chiroteuthis (Chirotauma) picteti* (Chiroteuthidae), *Liocranchia reinhardti* (Cranchiidae), *Hapalochlaena* cf. *lunulata*, *Octopus* cf. *abaculus*, *Octopus* cf. *aegina*, *Octopus* cf. *minor* group, *Octopus neglectus*, *Octopus* cf. *rex*, *Octopus* cf. *siamensis*, *Octopus* sp. large ud, *Octopus* small ud, *Benthoctopus* sp. A, *Benthoctopus* sp. B, *Benthoctopus* sp. C (Octopodidae). Of these, 11 species were new records for Thailand.

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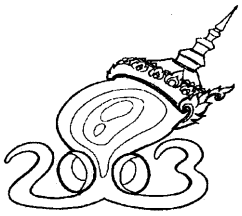

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# LATERALIZED EYE USE IN *OCTOPUS VULGARIS* ON THE POPULATION LEVEL

Behavioral lateralization has been demonstrated in many species of vertebrates. A recent study documented lateral asymmetry of eye use in *Octopus vulgaris* on the individual level. To include invertebrates in the discussion of evolution of lateralization we extended this study to the population level. Octopus eyes are located on the sides of the head and these animals prefer monocular over binocular vision. Eye use for frontal vision for twentyfive subjects was determined by recording the time the octopuses used to watch a stimulus outside the tank while holding on to the front glass of the tank. Thirteen subjects were highly significant left-eyed, nine highly significant right-eyed, and three did not have a preference. Because of the bimodal distribution found, we suggest that this behavioral asymmetry is determined and is not only a result of stress induced events in ontogeneny. Viewed from an evolutionary perspective, it seems that on the individual level it is important for an octopus to have lateralized eye use. But unlike handedness in humans, for the population level of eye preference in octopuses, it does not matter if individuals are biased towards left or right.

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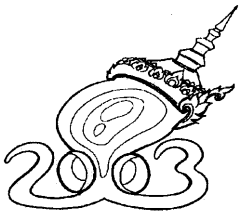


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# UNDERSTANDING CEPHALOPOD GROWTH: ASSESSING PROTEIN SYNTHESIS AND NITROGEN-FLUX

Measuring protein turnover provides an assessment of the recycling of amino acids between bound protein and metabolic pools where they are then available as energy substrates (or for re-incorporation into proteins). Generally, muscle tissue shows low turnover and a high retention efficiency of synthesised protein. There is limited information on protein turnover in cephalopods. Octopus showed a remarkably high retention of synthesised protein in the muscle and whole-body. This supports the concepts that cephalopods minimise recycling of amino acids back into a metabolic pool and maximise growth at the expense of protein repair. To explore this more fully we have investigated protein turnover through assessments of protein synthesis and protein-nitrogen flux into retention and excretion in the dumpling squid. Protein synthesis was measured in various tissues following a flooding dose of $^{3}$H-phenylalanine. The validity of the technique was confirmed by the maintenance of a flooding level of $^{3}$H-phenylalanine in the tissue free pools and linear incorporation of the label into protein over time. Preliminary results on small juveniles indicate variable but high rates of protein synthesis in mantle tissue that appear to be maintained by both the high capacity for protein synthesis (RNA:protein ratio) and high RNA activity.

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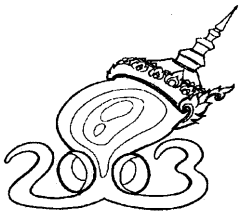


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# OCTOPUS' PROLIFERATIONS OFF THE COAST OF SENEGAL : ENDOGENOUS AND EXOGENOUS FACTORS

The first population explosion of *Octopus vulgaris* was observed in 1986 in Senegalese waters, after which catches varied considerably from one year to the next, reaching 40 000 metric tons in 1999. The factors that explain these variations are highlighted here.

- The life cycle is short - one year - with rapid growth and post-reproductive death occurring in both males and females. As a result there is no generation overlap.
- A female octopus lays an average of 250 000 eggs which it protects and ventilates, thus guaranteeing a high rate of survival at hatching.
- The survival of the planktonic larvae is directly influenced by the impact of environmental factors. Upwelling indices integrate the majority of these factors. Depending on the hydroclimatic conditions faced by larvae, the quantity of juveniles that result can vary considerably from one year to the other.
- Only big predators are capable of eating octopus but the number of this type of predator has been significantly reduced due to intensive fishing. Previously, they may have played a role in regulating the number of juveniles when these were particularly numerous.

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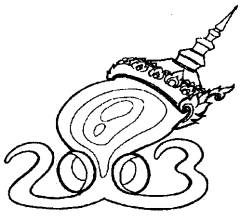

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# RELATIONSHIPS BETWEEN EARLY GROWTH VARIATION AND RECRUITMENT IN ENGLISH CHANNEL AND SCOTTISH WATERS *LOLIGO FORBESI*

The abundance of cephalopod resources often depends on the recruitment of the annual cohort. To improve our understanding of recruitment variability this study addresses the following question: "Does early growth vary in relation to recruitment [strength?]?"

*Loligo forbesi* populations are exploited in the English Channel and in Scottish waters. Spatial and temporal differences in body growth are sought by analysing samples from cohorts that showed marked differences in the abundance of recruits. Biological sampling showed that recruitment occurs in late winter spring in Scottish waters and in summer in the English Channel. Stock abundance estimates were higher in 1993 than in 1998. In both fishing seasons, samples collected monthly at fish markets were analysed and the age of recruits (mantle length < 20 cm) was determined with statoliths analysis. Daily growth increments on the statolith lateral dome were observed under a light microscope. Increments were counted using the image analysis software TNPC. Back-calculated hatching dates allowed estimation of growth variations during the pre-recruitment stage.

The analysis of individual growth variability enabled comparison within cohort and between cohort differences, looking both at inter-annual differences and differences between areas. Available recruitment estimates were used to test the hypothesis of density-dependance in squid growth.

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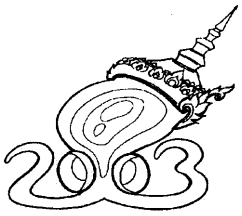

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# ANTARCTIC JAWS: TROPHIC RELATIONSHIPS BETWEEN SHARKS AND CEPHALOPODS, INCLUDING GIANT SQUIDS, IN KERGUELEN WATERS

Cephalopods play an important role in the trophic web of the Southern Ocean, where they are eaten by various top predators. Sharks from Antarctic waters are rare and nothing is known about their feeding ecology. We therefore examined cephalopod beaks in the stomach of 3 species of sharks taken as fishery bycatches at Kerguelen; first, to determine their diet, and second to gain new information on cephalopod biogeography in the southern Indian Ocean. The large sleeper shark *Somniosus* sp. (mean length 3.9 m, n = 36) has sperm-whale like feeding habits, preying upon *Kondakovia longimana* (40% by mass of the cephalopod diet) and *Taningia danae* (20%), and upon two species of giant squids, the worldwide *Architeuthis dux* (28%) and the endemic Antarctic *Mesonychoteuthis hamiltoni* (9%). Porbeagles *Lamna nasus* (1.9 m, n = 20) feed on *K. longimana* (19%) and on smaller squids, mainly *Todarodes* sp. (56%) and *Histioteuthis atlantica* (9%). Finally, the main squid prey of the small shark *Etmopterus* sp. (0.3 m, n = 12) is *Mastigoteuthis psychrophila* (85%). Cephalopod prey of sharks indicate the presence of at least 26 squid and 1 octopod species in slope waters of Kerguelen Islands, including some poorly known and still undescribed cephalopods.

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# THE INFLUENCE OF TEMPERATURE AND SALINITY ON THE STATOLITH OF THE OVAL SQUID *SEPIOTEUTHIS LESSONIANA* DURING EARLY DEVELOPMENTAL STAGES

*Sepioteuthis lessoniana* is an important fishery species in Taiwan. Its distribution is concentrated around the northeast coast and the southern coast of Taiwan, and the Peng-Hu Island. It has a high tolerance for salinity and temperature. Although there are some investigations on the statolith of the adults, studies on early stages are scarce. Clusters of bamboo were set up on the sea bed to attract their spawning, and the egg-strings were then transported to the laboratory. When the development of the embryo reached stage 24, they were transferred into different rearing conditions, 20, 25, 30, 35 $^{o}/_{oo}$ and 15, 20, 25, 30 $^{o}$C. The durations from stage 24 to hatching were different among all different rearing conditions. The statoliths were extracted and mounted in Crystal Bond thermoplastic cement for reading their growth rings. In the normal condition (25 $^{o}$C and 35 $^{o}/_{oo}$), the duration from stage 24 to hatching is 9 ~ 16 days. Although the rings can be counted in each specimen, the numbers do not match between the rings and the developmental duration. The numbers of rings and days reared were analyzed to test if the daily line was still formed in different environmental conditions.

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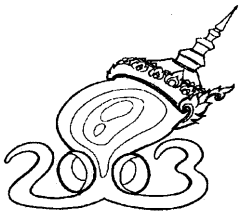


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# RANGE EXTENSION FOR TWO CEPHALOPOD SPECIES IN THE NORTHWESTERN GULF OF MEXICO

This is the first reported sighting of two species of cephalopods – *Loligo roperi* and *Octopus filosus* – within the Flower Garden Banks National Marine Sanctuary (Permit FGBNMS-2001-05A). Previously, only one species of cephalopod has been identified from the Flower Garden Banks area: *Loligo pealeii*. Three *L. roperi* were identified from specimens by Michael Vecchione (USNM) and several *O. filosus* were identified from video/photographs by John Forsythe (NRCC) and Roger Hanlon (MBL). *L. roperi* has previously been documented in the Bahamas while *O. filosus* has been documented in the Bahamas, Bonaire, and the Florida Keys. These sightings represent range extensions for these species. In addition, a juvenile *Illex coindetii*, normally found at depths of 366m, was captured above the coral reef (18m). The Flower Garden Banks are two geographically isolated underwater surface expressions of salt domes in the northwestern Gulf of Mexico. The banks are topped by approximately 350 acres of coral reef crest rising to 18.2m at its most shallow point. The banks effectively act as a reservoir for recruitment and settlement of coral reef and other species in the northern Gulf, with at least 300 species of fish and 21 species of coral. Specimens and field behavioral observations are described.

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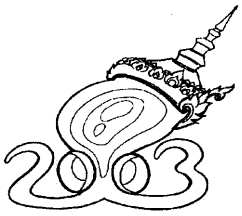

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# MATURATION, FECUNDITY AND SEASONALITY OF REPRODUCTION OF *EUPRYMNA STENODACTYLA*, GULF OF MANNAR SOUTHEAST COAST OF INDIA

The squid *Euprymna stenodactyla* is a poorly known small species inhabiting neritic waters of the Gulf of Mannar, south east coast of India. They are nocturnal and bury themselves in sand. The animals were studied from May 2001 to July 2002 and four reproductive stages were described using histology. Results of maturity indices conclude that spawning season was from April to June and the reproduction period was for four months. The first size at maturity was 28 mm for males and 31 mm for females. Fecundity was described by counting the number of mature ova, which ranged from 38 to 175 numbers. Detailed account on the structure of the reproductive system is also described.

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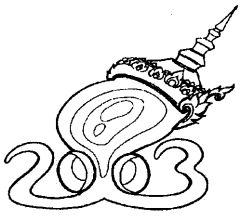

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# THE CHAMBERED NAUTILUS FISHERY OF NORTHWESTERN PANAY ISLAND, WEST CENTRAL PHILIPPINES: YIELD, FISHING PRACTICES AND SEASONALITY

The chambered nautilus (*Nautilus pompilius*) fishery of Antique province, Panay Island, west central Philippines was studied between the years 2001-02. Data for catch, catch per unit effort (CPUE) were collected from fishermen's records and the fishing patterns were documented based on interviews with fishermen. Length-weight and length-frequency data were also obtained during the period of the study. Results show that catches are seasonal, and that fishing operations are limited only to a number of months each year. Seasonality of catches is due partly to weather conditions and the availability of bait material. The fishing grounds are limited largely to the nearby areas along the Tibiao coast of Antique. The mean estimated rate of catch during the study period is equivalent to 0.03 kg $trap^{-1}$ $h^{-1}$. This translates to a mean daily catch of about 100 kg $day^{-1}$, or 600 kg $mo.^{-1}$ for the Tibiao fishing area. The fishery exists primarily for the shells which are sold for decorative purposes at an average of PhP 35.00 $pc^{-1}$ ($1 = PhP 50), whereas the meat is sold fresh in local markets at about PhP 35.00 $kg^{-1}$. Other biological information, especially pertaining to reproduction, is also being gathered.

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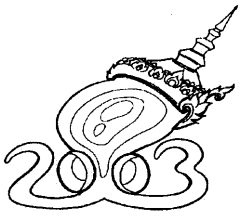

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# THE DYNAMICS OF BENTHIC TURBIDITY ON THE SPAWNING GROUNDS OF CHOKKA SQUID (*LOLIGO VULGARIS REYNAUDII)* AND LINKS TO SQUID CATCHES.

Highly erratic yearly catches in the chokka squid (*Loligo vulgaris reynaudii*) fishery are thought to be linked to atmospheric and oceanographic variability along the South African south coast. More specifically, several studies indicate that turbidity is the single most important parameter that negatively affects the behaviour of spawning chokka squid and catches as a result of reduced underwater visibility ("black out" conditions) and the impairment of visual chromatophoric signaling used in communication during spawning. Such disturbances impact spawning aggregations and hence catches. To understand this relationship an intensive study to determine the dynamics and characteristics of turbidity events, and the effect on catch fluctuations of chokka squid, was initiated in Kromme Bay, Eastern Cape. Results show turbidity to occur on the inshore spawning grounds but was restricted to depths shallower than 100m. Case studies showed that turbidity negatively influenced squid catches. It was found that other environmental variables *i.e.* increased wave height, wind strength and warmer water, negatively influence catches indirectly due to their influence on turbidity. The presence of turbidity events within the main spawning grounds during the 1999 and 2000 closed fishing seasons resulted in very low squid catches. This indicated that little spawning occurred and that the closed seasons were ineffective. Turbidity, therefore, not only directly influences catches but also has implications for recruitment.

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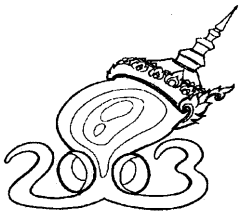

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# PHYLUM DICYEMIDA IN AUSTRALIAN WATERS: FIRST RECORD AND DISTRIBUTION ACROSS SHALLOW-WATER CEPHALOPOD HOSTS.

Dicyemid mesozoans are marine organisms that live exclusively in the excretory organs of cephalopod hosts. This study constitutes the first record of the Phylum Dicyemida from Australian waters and provides information on the degree of infections within and between shallow-water host species, and on the distribution of dicyemids across latitude. A total of 38 cephalopod species from 8 families were collected live throughout southern, eastern and western Australia, and investigated for the presence of dicyemids. Individuals from 24 cephalopod species were found to be infected, generating new host records of dicyemids for 23 species, 5 genera (*Euprymna*, *Grimpella*, *Hapalochlaena*, *Sepiadarium*, *Sepioloidea*) and one family (Sepiadariidae). This investigation represents the first detailed cross-latitudinal survey of dicyemids. Findings of dicyemids in three tropical octopus species (*Octopus alpheus*, *O. dierythraeus* and *O. ornatus*) and multiple findings of uninfected adult benthic cephalopods in temperate regions allow us to re-evaluate and modify concepts of latitudinal trends proposed in previous studies on this group of parasites.

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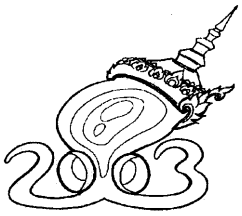

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[2]Inter-American Tropical Tuna Commission. 8604 La Jolla Shores Drive. La Jolla, California 92037-1508.

# DISTRIBUTION OF CEPHALOPODS IN THE EASTERN PACIFIC OCEAN BASED IN STOMACH CONTENTS OF LARGE PREDATORS

The number of 8 298 stomach samples were analyzed from 27 different predators including sharks, tunas, billfishes, dolphins, mahi-mahi, wahoo, etc., collected aboard of the tuna purse seiner that fish in the EPO waters during 1992 to 1994. Twenty cephalopod species were recorded, based mostly in squid beaks. The octopods recorded were: *Argonauta nouryi, Argonauta pacifica, Argonauta* spp., *Japetella diaphana, Octopus rubescens, Tremoctopus violaceus, Alloposus mollis, Vitreledonella richardi* and *Vampyroteuthis infernalis*; where the decapods identified were*: Octopoteuthis deletron, Thysanoteuthis rhombus, Dosidicus gigas, Sthenoteuthis oualaniensis, Onychoteuthis banksii, Pholidoteuthis boschmani, Abraliopsis falco, Abraliopsis spp., Mastigoteuthis spp., Loligo opalescens* and *Liocranchia reinhardtii*. We discuss the cephalopod distribution found in the EPO and importance of predators as sampler of cephalopods.

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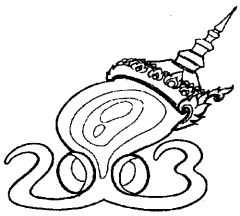

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# CEPHALOPOD DIVERSITY, FISHERIES AND CULTURE IN INDONESIA

Cephalopods occur throughout the Indonesian seas, which make this area one of the main contributors to the world cephalopod fisheries, particularly for squid and cuttlefish. From specimen collection carried out since 1985 throughout the region, fourty four species were identified. The collection represents 11 loliginid squid, 3 sepiolids, 5 ommastrephids, 13 sepiids, 7 octopods, 2 argonautids, 2 nautiloids and 1 spirulid. Eleven identified species (or 25% of total) are evident to show a wide range of regional distribution, *i.e. Loligo edulis, L. chinensis, L. duvauceli, L. sumatrensis, Sthenoteuthis oualaniensis,, Sepioteuthis lessoniana, Abralia spaercki, Sepia latimanus, S. aculeata,, S. pharaonis* and *Sepiella inermis.* These species were collected from major fish landings in most provinces of the country, including West Sumatra, Aceh, North Sumatra, Riau, South Sumatra, north and south coast of Java, Bali, Timor, South, East and West Kalimantan, South, Central and North Sulawesi, Maluku and Irian Jaya.
A total country landings of about 46,842 tons were taken in 1998, consisting of 31,850 tons squid, 11,473 tons cuttlefish and 3,519 tons octopus. Significant cuttlefish landings has been made from the north coastal water of Java, the east coast of Sumatera and the Maluku seas, by various coastal seine nets. Squid has been important target in the pelagic fisheries in West Nusa Tenggara, South Sulawesi, and Maluku. There is evidence of interactions between squid and other small pelagic fisheries in the Straits of Alas and Bali.
Experiments on cephalopod culture has started in 1987 (Ghofar, 1989) for four species (*Sepioteuthis lessoniana, Loligo edulis, Sepia bandaensis, Sepia latimanus*). Although further effort (Ahmad *et al*, 1999; Danakusumah *et al*, 2000) was attempted to prepare mass culture of *S. lessoniana* in cage with little success, this species have been culture through life cycle. Major problems related to cephalopod fisheries and culture in Indonesia are discussed.

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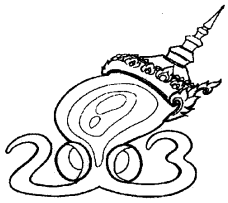


**GLEADALL, Ian**
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## CEPHALOPOD BIODIVERSITY: THE TWILIGHT ZONE

A number of poorly described genera, subgenera, species and subspecies of octopus are redescribed and illustrated from recent inspection and new measurements of original type material. Included are several names for which the types have been recently declared "lost" or "not extant" and others subjectively (*i.e.* unjustifiably) declared to be *nomina dubia.* Most of these names have been subsequently excluded from the contemporary literature, justified by the claim that "the presence of so many inadequately described taxa" is inhibiting descriptions of new taxa. It is argued here that names regarded as invalid, for whatever reason, should be appropriately categorized but readily accessible for easy future reference, and for reassessment when the establishment of a new taxon is being considered. A brief checklist is presented for declaring *nomina dubia* more objectively and some examples are provided. To quickly reach a stable nomenclature for the Cephalopoda, efforts should be made to ensure that all names, whatever their status, are accessible both in printed form and from Cephbase. A list of 'currently invalid names' could easily be incorporated into Cephbase, probably most conveniently as a 'twilight zone' satellite database.

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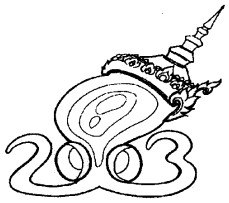


**GOTO, Tsuneo**
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# EXAMINATION OF DIFFERENT PRESERVATIVES FOR *TODARODES PACIFICUS* PARALARVAE FIXED WITH BORAX-BUFFERED FORMALIN–SEAWATER SOLUTION

Influence of different preservatives on fixed specimens was examined. Materials were 36 T*odarodes pacificus* paralarvae sorted out under tap water in the laboratory from net samples fixed with 5-10% borax-buffered formalin-seawater solution aboard. After the dorsal side was photographed focused on chromatophores and the mantle length was measured, paralarvae were divided into 6 groups and each group was immersed in the following different preservatives, 1) 5% phosphate-buffered formalin 2) 5% borax-buffered formalin 3) 5% hexamine-buffered formalin 4) 99% ethanol 5) 70% ethanol and 6) 40% isopropanol. Diluents of the preservatives were distilled water. Each paralarva was put into 2 ml screw vial, and then stored in a dark place. After 3, 6, 9 and 12 months, the photography and mantle length measurement were done individually. In preservatives 3)-6), the chromatophores have almost remained for 12 months, however specimens in 1)-2) showed considerable translucent after 3 months. In addition, specimens in 5) were remarkably shrunk (20%) after 3 months and in 4) and 6) were slightly shrunk after 12 months. In 1)-3), the certain changes of mantle length were undetected as the month elapsed. The results show that the 5% hexamine-buffered formalin may be a better preservative.

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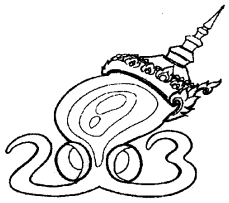


**GRIEBEL, Ulrike and Jennifer A. MATHER**
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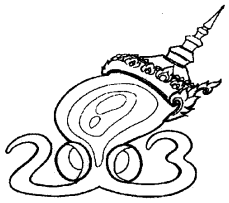
## DOUBLE SIGNALING IN *SEPIOTEUTHIS SEPIOIDEA*

*Sepioteuthis sepioidea*, the Caribbean reef squid has one of the most complex color pattern repertoires among cephalopods. It uses a wide variety of color patterns for courtship, aggression, startling and camouflage. The color patterns can be produced directionally, *i.e.*, on the body part closest to the receiver. They also can produce two different signals simultaneously for two different receivers, a special feature we call double signaling. The majority of double signals are produced by males during courtship when a courting male is approached by a rival male. In this situation the courting male produces a courtship signal towards the female and an aggressive signal towards the adversary. The most common combination is the aggressive pattern called Zebra with Flicker or Stripe, the two male courtship patterns. In females as well as in males we also observed combinations of courtship patterns and startling patterns when a courting animal was surprised by *e.g.*, an approaching fish. Double signaling within one communication channel is a rare feature in communication systems and has not been reported to occur in any other non-human animal.




**GRIGORIOU, Panos, Christopher RICHARDSON and Andrew YULE**
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# THE EFFECTS OF TEMPERATURE AND ACCLIMATION ON OXYGEN CONSUMPTION BY JUVENILE CUTTLEFISH, *SEPIA OFFICINALIS*

Measurements, using closed respirometry, of the oxygen consumption of laboratory-reared juvenile cuttlefish *Sepia officinalis*, (size range 14-67g wet weight), were taken at seawater temperatures ranging between (6-28ºC). Twenty cuttlefish (mean wet weight 22.37±1.2g) were acclimated for 2 weeks to four seawater temperatures (8, 13, 18 & 23ºC), and their oxygen consumption, when exposed to a range of acute seawater temperatures (6-28ºC), measured. $Q_{10}$ values ranged between 1.3 and 3.7. Oxygen acclimation curves were constructed for cuttlefish maintained at 8, 13, 18 & 23ºC. The aims of the work were to develop a model relating body size, respiration and seawater temperature. Oxygen consumption in cuttlefish is discussed in relation to stocking densities, transport of juveniles and acclimation to sudden changes in seawater temperatures.

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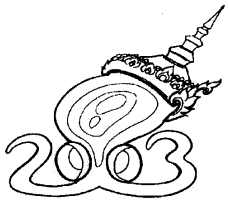


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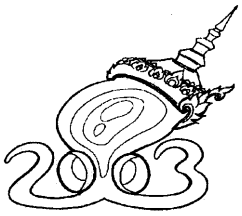
# TWO NEW SPECIES OF *SEPIA* (DORATOSEPION) (CEPHALOPODA: SEPIIDAE) FROM TAIWAN, BASED ON MORPHOLOGICAL AND MOLECULAR DATA.

Two forms of *Sepia* belonging to the Doratosepion group, tentatively called TW-18A and TW18B, are found from the waters off Taiwan. The posterior ends of fins of both forms extend posteriorly to form long "tails", but there are differences in "tail" length, cuttlebone shape, the shape of the anterior striae of the cuttlebones, and the length of the 2nd arm. The two forms have different distribution in Taiwan, TW18-A occurs in the north-east and TW18-B occurs in south-west of Taiwan. Analyses of genetic distance by mitochondrial DNA cytochrome c oxidase subunit I sequences reveal that there are 0.30% variation in TW18-A, 0.64% in TW18-B and 3.68% between TW18-A and TW18-B. Based on morphological and molecular evidances, we report these two forms are two valid species and both of them are new to science.



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# ARROW SQUID AND THE COASTAL ECOSYSTEM: USING ACOUSTIC TECHNOLOGY TO UNRAVEL THE ECOLOGY

Acoustic telemetry technology is being coupled with traditional tagging techniques to investigate movement patterns of Ommastrephid arrow squid *(Nototodarus gouldi*) in southeastern Tasmania. This study will provide insights into their ecosystem role and interactions, as well as an increased ability to predict availability to the fishery and the effects of the fishery, information crucial for the development of management policies.

Thirty arrow squid have been tagged with small, uniquely identifiable acoustic tags, detectable when within 500m of a single-channel VR2 receiver (Vemco). Over 80 receivers have been aligned to 'curtain off' the many bays and inlets in the southeast region of Tasmania so that an acoustically tagged animal moving more than 20-30km in any one direction will be detected, and the time and tag ID recorded. Traditional t-bar tags are used to supplement the acoustic tags, providing the volume of data needed to make population level inferences about general movement patterns.

In addition to establishing general coastal migration patterns, the tagging techniques will answer specific questions about the timing, regularity and scale of movement patterns at a variety of spatial scales, including movement between inshore and offshore areas, protected areas and fishing grounds.

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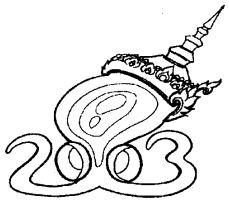


**HOYLE, K. A., Jayson M. SEMMENS & Gretta T. PECL**
Marine Research Laboratories, Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, P.O. Box 252-49, Hobart, Tasmania 7001, Australia

# EXAMINING THE EFFECT OF SEASONAL TEMPERATURE CHANGES ON OCTOPUS GROWTH

Laboratory studies using fixed temperatures have highlighted the major impact of this factor on cephalopod life histories, with individuals reared under different temperature regimes exhibiting wildly different growth characteristics. However, the precise effect of seasonal temperature regimes on wild populations is unknown, as are the mechanisms of muscle growth that facilitate these plastic responses. With squid, you can age field-caught individuals and establish the influence of temperature on growth under natural conditions. However, this is not possible with octopus, as there is currently no reliable ageing method available. This study reared *Octopus pallidus* individuals under simulated natural temperature regimes – seasonally increasing and decreasing, as well as a control treatment at constant temperature. Growth was examined at the whole animal level, with individuals weighed every two weeks. Individuals from the three temperature regimes all displayed exponential growth, however, octopus reared under increasing temperatures demonstrated the fastest growth rate, with animals in the decreasing and increasing regimes almost identical in the nature of their growth. Histological examination of mantle muscle tissue of animals killed throughout the experiment detailed how the cellular growth mechanisms of hyperplasia and hypertrophy were altered under the different temperature regimes and ultimately expressed at a whole animal level.

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**HSUEH, Meng-Min and Chung-Cheng LU**
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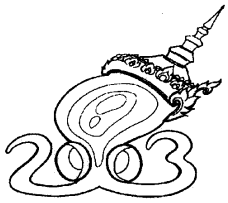
# MORPHOLOGY AND POSSIBLE FUNCTION OF CAUDAL GLANDS OF *SEPIELLA JAPONICA* SASAKI, 1929 (SEPIIDAE: CEPHALOPODA)

The caudal gland of *Sepiella* is a conspicuous, and a diagnostic character of the genus *Sepiella*. This gland of *S. japonica*, a common species in Taiwan was studied. There are iridophores in the connective tissue of the hypodermis of the dorsal skin above the gland and observations reveal that the animals have the ability to control the expression of the caudal gland. The posterior fin conjunctive muscle surrounds the caudal gland. The epidermis of the caudal gland is composed of the simple columnar epithelial cells, and the secretion is secreted from the epithelial cells. There are many dark brown granules in the secretion and the secretion can be emitted at will. The length of the caudal gland is about 15.7% of the dorsal mantel length. A positive trend between the caudal gland size and the dorsal mantle length exists. There is no significant difference in the caudal gland sizes between males and females. The cobia juveniles fed with caudal glands or cuttlefish flesh drenched with caudal gland secretion disgorged the food immediately, indicating the cobias dislike a certain substance in the secretion. It is concluded that defense is among the functions of the caudal gland.




**HUFFARD, Christine L.**

# MATING STRATEGIES IN A MEMBER OF THE *OCTOPUS ABDOPUS* SUB-GENUS FROM SULAWESI INDONESIA: FIRST REPORT OF MATE GUARDING IN OCTOPUS

Mate guarding behaviour and true satellite sneaker males are reported here for the first time in any octopus. Unlike multiple matings reported in *Octopus vulgaris*, *Octopus bimaculatus* and *Octopus cyanea*, males of an undescribed member of *Octopus* (*Abdopus*) from Sulawesi, Indonesia (OA1) utilize different behavioral strategies to procure copulations with a nearby female. Large male and female OA1 pair occupied dens within arm's reach of each other for up to five successive days, and this large male remained within 2m of the neighboring female while she foraged and during most of the time at the den. "Guarding" males successfully chased all other males from the female except two cases when sneaker mating by a well-camouflaged male was tolerated. Smaller "satellite" males often occupied dens within a 3-meter radius of the male-female pair, and typically procured sneaker matings with the female while the guarding male was in its den. Guarding males possessed enlarged suckers, frequently displayed black and white longitudinal stripes and sat with their eyes high above the substrate, while satellite males typically lacked enlarged suckers, were well-camouflaged and adopted the striped display only when chased by the large male or at the start of a mating attempt. Females typically lacked enlarged suckers, were well-camouflaged, and exhibited a behavior similar to the sucker display of *Octopus vulgaris*. Costs of these mating strategies, such as severely reduced foraging rates by guarding males, frequent aggressive interactions and arm injuries, and likelihood of displays to increase interactions with fish, are discussed.

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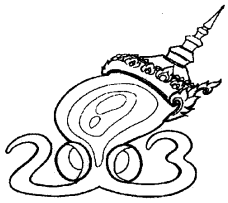


**ICHII, Taro[1], Kedarnath MAHAPATRA[2] and Mitsuo SAKAI[1]**
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# WHY IS THE BODY SIZE OF THE NEON FLYING SQUID (*OMMASTRAPHES BARTAMII*) OF THE AUTUMN COHORT MUCH BIGGER THAN THAT OF THE WINTER-SPRING COHORT IN THE NORTH PACIFIC?

Neon flying squid (*Ommastraphes bartamii*) which form an important part of fishery in the North Pacific consist of autumn and winter-spring cohorts. Factors causing significant difference in body size between the autumn and winter-spring cohorts considering the consecutive hatch dates were investigated by comparing the ocean condition in their respective spawning grounds and foraging migration in relation to the transition zone chlorophyll front (TZCF). Formation of spawning ground was located at about 28-34˚N in autumn while at about 20-28˚N in winter and spring. Autumn spawning ground coincided with the subtropical front characterized by enhanced productivity and subsequently became food-rich nursery ground in winter due to close proximity to the TZCF, which moves southward to the subtropical front in winter from its summer location at the subarctic boundary. Winter-spring spawning ground, on the other hand, coincided with the subtropical region, which is less productive throughout the year. As the TZCF shifted northward in spring and summer, the autumn cohort had an advantage of being in the productive area north of the TZCF, while the winter-spring cohort in less productive area south of it, due to their respective northward migrations. Thus, the autumn cohort could make efficient use of the food-rich habitat from winter through summer, leading to much larger body size than that of the winter-spring cohort.

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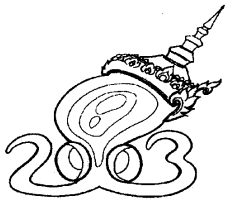


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# THE EFFECT OF LOW TEMPERATURE ON THE REPRODUCTIVE ACTIVITY OF *LOLIGO BLEEKERI* KEFERSTEIN, 1866

Spawning aggregations of *Loligo bleekeri,* a northern species of Loliginidae, support a fishery in the northern Sea of Japan. In this study, we examined the relationship between the daily catch and water temperature on the spawning grounds. The CPUE differed significantly as the water temperature ranged between 5ºC to 11ºC, increasing noticeably below 7ºC. The frequency of courtship (displays of sexually dimorphic body pattern), copulation, and the number of spawned ova were used as indices of reproductive activity in captive squid held at 5º and 6ºC. At 5ºC, the frequency of courtship and copulation was low. Little spawning occurred and the proportion of fertilized ova per egg capsule was low (16.5±2.5%, mean±SE). At 6ºC, the frequency of copulative attempts by males increased, but rejection by females was high. Few eggs were spawned, and only 14.6±4.5% were fertilized. The minimum temperature for successful egg development and hatching coincides with restricted reproductive activity of *L. bleekeri* and would presumably affect its spawning migration.

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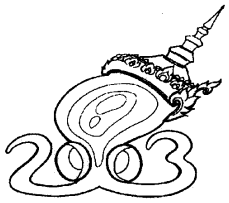


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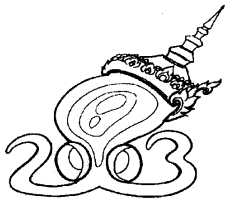
## SQUID AS BAROMETERS OF ENVIRONMENTAL CHANGE, LIFE IN THE FAST LANE

Age growth and life history studies are revolutionising our understanding of the life styles of squid. Both statolith ageing of field individuals and culture studies reveal that squids respond rapidly to environmental change. The most profound influences appear to be temperature, food and oceanic conditions. Previous work on a variety of loliginids (*Sepioteuthis lessoniana*, *Lolliguncula brevis*, *Loliolus noctiluca*) have revealed the dramatic influence that temperature has on squid growth. More recently, work on *Loligo opalescens* off Southern California have fond that body size and growth rate of this species changes dramatically in response to El niño or La niña conditions. Such rapid changes to environmental fluctuations make squid ideal barometers to track the oceanic conditions in the California Current. More recent work on the Australian ommastrephid *Nototodarus gouldii* have revealed both spatial and temporal changes in growth rate and body size suggesting that this species can be used as an environmental barometer in Australian near-shore waters.

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# SPECIES DISTRIBUTION AND SPAWNING GROUNDS OF CUTTLEFISH IN THE UPPER GULF OF THAILAND

Study on the species distribution and spawning grounds of the cuttlefish in the upper Gulf of Thailand was conducted during January to October 2002. The samples were collected, using an otter board trawl of the research vessel, offshore in 3, 5, 7 and more than 7 nautical miles zones. The main cuttlefish species collected in the studied zones were *Sepia aculeata*, *Sepia recurvirostra* and *Sepiella inermis*, while *Sepia pharaonis* and *Sepia brevimana* were rare during the studied period. *S. aculeata* and *S. inermis* were abundant nearshore, within 7 nautical miles, but *S. recurvirostra* were found mainly offshore, more than 7 nautical miles. The nursing ground of *S. aculeata* and *S, inermis* were assumed to be within 3 nautical miles inshore because of the high abundance of mature cuttlefish collected. Although, mature *S. recurvirostra* was abundant in the zones of more than 7 nautical miles offshore, the spawning ground could not be defined because the collected specimens were of all stages of maturity.

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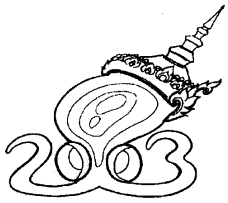


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[2]Rayong Coastal Fisheries Research and Development Center, Ta-Pong, Changwat Rayong 21000, Thailand

# DESCRIPTION OF HATCHLING OF THAI TYPE OF BIGFIN SQUID, *SEPIOTEUTHIS LESSONIANA* LESSON, 1830, WITH NOTE ON COMPARISON TO JAPANESE TYPES

Morphological characters of hatchlings of the Thai type of bigfin squid, *Sepioteuthis lessonniana*, are described. Hatchlings of the Thai type of bigfin squid have muscular and cylindrical mantle, elongate bell-shape with round blunt end. Fins are broad, round, almost circular in outline, subterminal. The head is squarish in outline, flattened dorso-ventrally. The chromatophores are scattered on the dorsal and ventral side of mantle and the numbers are 118.7 and 135.6, respectively. Morphological characters of three Japanese types of *Sepioteuthis lessonniana*, the quaking type, red type and white type are compared. Notable differences are the numbers of chromatophore on mantle and fins as well as the numbers of series of chromatophore on arms and tentacles. Numbers of chromatophore of the Thai type are less than of the quaking type, 118.7 on dorsal mantle and 61 chromatophores on dorsal fins to 191 and 125 chromatophores, respectively. Numbers of series of chromatophore on arms II, III, IV and tentacle are 2, 5, 1 and 5 rows in the Thai type and 3, 7, 2 and 6 rows in the quaking type, respectively. The numbers of chromatophore on dorsal fins of the Thai type are less than of the red type, 61 to 70.7 chromatophores, respectively. The numbers of chromatophore series on arm III and tentacle are 5 and 5 rows in the Thai type and 4 and 6 rows in the red type, respectively. The numbers of chromatophores on dorsal fins of the Thai type are less than of the white type, 61 to 86 chromatophores, respectively. In contrast, the numbers of chromatophore on the ventral side of the head of the Thai type are higher than of the white type, 31 to 22.7, respectively.

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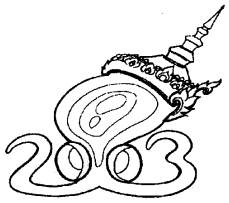

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# DESCRIPTION OF HATCHLING OF THAI PYGMY SQUID, *IDIOSEPIUS THAILANDICUS*, CHOTIYAPUTTA, OKUTANI & CHAITIAMVONG, 1991

Morphological characters of hatchlings of the Thai pygmy squid, *Idiosepius thailandicus*, are described. Hatchlings of the Thai pygmy squid are 0.85-0.9 mm in dorsal mantle length with firm and cylindrical mantle, bell-shaped with round blunt posterior. Dorsal margin of the mantle is plain. The ventral margin is slightly excavated. Fins are separated, subterminal, distally free, projecting slightly beyond the posterior mantle. Each fin is small, oval-round in outline. Head is squarish in outline. Eyes are large, not protruding and situated anterior on the head. The funnel is broad and short. Arms are short and stout with blunt tips. Arms IV are very short. Arm formula is II, III, I, IV. The suckers are biserial almost spherical, and of equal size. There are 4-6 suckers on arm I-III but no sucker on arm IV. The hatchling specimens are without tentacles. The dorsal mantle carries 0-30 chromatophores and ventral mantle carries 15-20 chromatophores. Arrangements of six and four chromatophores on dorsal and ventral mantle-head, respectively, are symmetrical. Arms carry 1-2 chromatophores on the aboral side.

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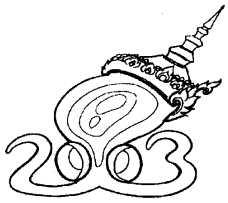


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# THE ROLE OF CANNIBALISM IN THE TROPHIC ECOLOGY AND POPULATION STRUCTURE OF *ILLEX ARGENTINUS* AND *LOLIGO GAHI*

Cannibalism is a feature of cephalopod feeding biology and has been recorded in ommastrephid and loliginid squid. Although cannibalism is undoubtedly important to natural mortality, the nature of cannibalism has not been systematically studied in squid and there is no consensus on its importance. This study focuses on *Illex argentinus* and *Loligo gahi*, which are the subject of large scale international fisheries in the southwest Atlantic, and addresses key aspects of their trophic ecology which are currently unknown. The diets of *I. argentinus* and *L. gahi* are examined to quantify the importance of cannibalism and the role these squid in the marine food web of the southwest Atlantic. The work examines the impact of cannibalism on the natural mortality of *I. argentinus* and *L. gahi*, and considers ways in which this may affect population dynamics. The influence of inter-annual variations in food availability and population density on the extent of cannibalism in *I. argentinus* and *L. gahi* is explored.

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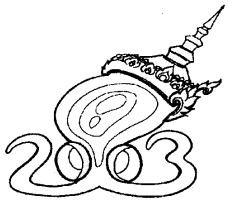


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# IDENTIFICATION OF GONATID SQUID SPAWNING AREAS IN THE BERING SEA AND GULF OF ALASKA BASED ON PARALARVAL DISTRIBUTION, WITH COMMENTS ON PARALARVAL TAXONOMY

An extensive database of cephalopod paralarvae has been established from plankton samples collected during ichthyoplankton surveys conducted by the National Marine Fisheries Service in the Bering Sea and Gulf of Alaska from 1991 to present. Preliminary examination of incidences of cephalopod paralarvae indicate temporal and spatial spawning events in two areas; the first is along the southern portion of the shelf break in the Bering Sea and the second is along the shelf break southwest of Kodiak Island in the Gulf of Alaska, both areas have peak abundances in late April and early May. Many of the specimens from these areas are smaller than published descriptions, making identification difficult. However, preliminary results indicate the assemblage of larval cephalopods in the spawning areas consists of at least three different species and that the development of the third and fourth arm pairs is similar for Gonatidae and Onychoteuthidae paralarvae.

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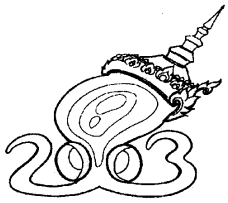


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# COMBINING FISHING CLOSURE WITH MINIMAL SIZE OF CAPTURE TO IMPROVE OCTOPUS PRODUCTION IN SENEGALESE WATERS: AN EVALUATION USING ANALYTICAL MODELLING.

The dynamics of the *Octopus vulgaris* population in Senegalese waters is modelled to evaluate the potential impact of combining temporal fishing closure and minimal size of capture on the production of this stock. The study is based on an analytical approach (cohort analysis and simulation of captures on a monthly basis) adapted to the biological characteristics of *O. vulgaris*, a short lifespan species. Several combinations of the two policies (minimal size and fishing closure) are tested to complete the results of previous studies that evaluated each of the two strategies separately and in addition, to account for the fact that a positive synergic effect can be expected. The model covers the exploitation period from 1996 to 1999. As in the previous simulations (of separate effects), the present results focus on the instability of the responses (positive or negative, significant or not, depending on the situation that prevailed each year) of the octopus stock to such policies. As a consequence it is difficult to identify the ideal combination of closure and limiting size that would ensure a substantial improvement of production each year.

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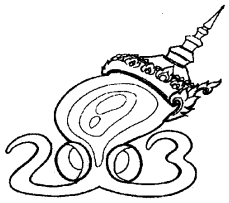


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# A SHALLOW WATER OCTOPUS SPECIES OF THE SUBGENUS *ABDOPUS* (CEPHALOPODA: OCTOPODIDAE) FOUND IN OKINAWA, JAPAN

Species in the new subgenus *Abdopus* (Norman 2001), genus *Octopus*, are characterized by small body size, long arms and sculptured skin. They are known to occur in the Indo-West Pacific region. Here I report finding an unidentified octopus species at Henza located in the east coast of Okinawa Island, northern limit of the Indo-Pacific. This octopus digs dens on the tidal flat and these dens are found in large aggregations. The octopus has sculptured skin with many papillae on the mantle and webs. Its body color is brownish or grayish in life and it may help their concealment on reef substrates. Some individuals from this location were examined morphologically. They possessed a small to medium mantle (40-60mm) and arms that were more than 6 times longer than their mantle. Either the second or the third arms were the longest and the paired front arms were the shortest. They are capable of autotomising their arms at the base. These observations suggest that this octopus species is a new locality record for the subgenus *Abdopus* in Okinawa Island. There is evidence that there are several other unidentified shallow water octopuses in Okinawa, indicating the need for further investigation.

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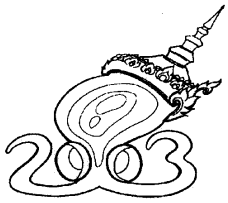


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# LIFE CYCLE OF THE JAPANESE PYGMY CUTTLEFISH *IDIOSEPIUS PARADOXUS* (CEPHALOPODA: IDIOSEPIIDAE) IN THE *ZOSTERA* BED AT THE TEMPARATE COAST OF CENTRAL HONSHU, JAPAN

Life cycle of the Japanese pygmy cuttlefish, *Idiosepius paradoxus*, in the *Zostera* bed was studied at the temperate coast of central Honshu, Japan. *I. paradoxus* was collected monthly from January 1998 to December 1999. This species showed sexual dimorphism and females were considerably larger than males.
The adult size of this species changed with seasons. The small sized generation appeared in warm season from late spring to early autumn. In the warm season, mature males with spermatophores in Needham's sac began to appear from late spring, and mature females with ripped eggs appeared from early summer. In the cool season from late autumn to early spring, the individuals grew gradually and larger with sexual mutuality at spring. Although the individuals in the late autumn were larger than those of the warm season, they were not sexually matured. In the present study area, the larger sized generation passed winter matured and spawned at next spring, and moreover, the small sized generation in the warm season matured from late spring to early autumn. In conclusion, it was suggested that *I. paradoxus* have at least two generations with in one year.

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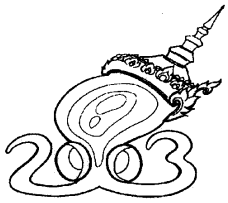


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# THE GONATID SQUIDS – WHY DO SOME OF THEM BECOME WATERY UPON MATURATION?

Reproductive biology of most oceanic squids remains to a greater part unknown. At least several species of the oegopsid family Gonatidae experience considerable changes in appearance upon the beginning of reproductive period. Ontogenetic changes in morphology of two abundant gonatid species, *Gonatus madokai* and *Gonatus tinro*, from the Sea of Okhotsk have been considered. While sexually mature males of both species remain basically unchanged, females change dramatically. Their muscles start to become watery at the onset of maturation, and by the beginning of spawning females are almost water-logged having thick swelled mantles and arms. Shreds of black tissue attached to the arm-hooks of some females are evidently remnants of the egg-mass carried by a squid after spawning. Evolutionary developed life-history strategy of both species, as well as of some other gonatids, resulted in adaptations for prolonged brooding of large-sized developing eggs in the egg-mass carried by a female within the arm crown. Those adaptations concern buoyancy and safe-mode parental care in pelagic layers. Medusoid watery muscle tissues provide neutral buoyancy for egg-carrying females turning them into floating safe deposits of developing embryos.

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Japan Sea National Fisheries Research Institute, FRA, Japan

# CAUSE OF THE CHANGE OF PARALARVAL DISTRIBUTION RANGE FOR THE JAPANESE COMMON SQUID *TODARODES PACIFICUS* IN THE SEA OF JAPAN

The biomass of *Todarodes pacificus* decreased in the Sea of Japan during 1970s and 1980s. Then it turned to increase in 1990s, and keeps high stock level now. Before the middle of 1970s and in 1990s the paralarval distribution ranged southwestern part of the Sea of Japan and East China Sea. But it contracted to only southwestern part of the Sea of Japan in 1980s. In this way, the range of paralarval distribution of *T. pacificus* has been changed with the stock level. In this study, we examine the spawning migration routes that were estimated by tagging experiments, and tried to show the change of paralarval distribution range from the change of spawning migration route. In the periods of high stock level, *T. pacificus* usually migrated along the north of sub-arctic front to the eastern coast of Korea, then reached East China Sea. But in the periods of low stock level, they seldom migrated to the East China Sea. Instead, they often migrated to the coast of the Japanese mainland, crossing sub-arctic front. We conclude that the change of paralarval distribution is caused by the changes of spawning migration route, which might be affected by environmental conditions.

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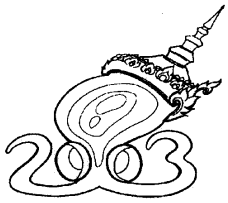
# FINDING JAPANESE COMMON SQUID (*TODARODES PACIFICUS*) MIGRATION ROUTES IN THE JAPAN/EAST SEA

In this study, we consider temporal and spatial variability of *Todarodes pacificus* fishing ground and migration routes in Japan/East Sea detected by Operational Linescan System (OLS) images generated by the Defense Meteorological Satellite Program (DMSP), since *T. pacificus* are caught at night using powerful lights. DMSP/OLS nighttime visible images from 1994 to 1999 were examined and we defined *T. pacificus* fishing ground as the bright area in DMSP/OLS images created by two-level slicing methods. Investigating time and location of squid fishing ground appearance, we try to divide the Japan/East Sea into several provinces with similar seasonal variability using cluster analysis.

The *T. pacificus* fishing grounds were mainly found along the east coast of Korea, between Cheju and Tsushima Islands, around Yamato bank, along Honshu, and north area of Japan/East Sea. As a result of cluster analysis, we could divide the Japan/East Sea into nine areas. This result can be thought of two migration routes, which are northern migration and southern migration pattern. One of the northern migration patterns was formed along Honshu Island to north and another pattern is along east coast of Korea, through Yamato bank to north. Southern migration pattern is almost vice verse of northern migration pattern.

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Laboratoire de Biologie et Biotechnologies Marines, Université de Caen, 14032 Caen Cedex. France. Tel : 33 231 53 80 16 ; Fax 33 231 53 80 09. E-mail koueta@ibba.unicaen.fr

# EXPERIMENTAL STUDY OF THE EFFECT OF ENRICHED FROZEN DIET ON DIGESTIVE ENZYMES AND GROWTH OF JUVENILE CUTTLEFISH *SEPIA OFFICINALIS* L. (MOLLUSCA CEPHALOPODA)

Juvenile cuttlefish hatched in the laboratory were reared during 10 days with live shrimps enriched in polyunsaturated fatty acids (PUFA), then divided in 4 dietary groups fed respectively on live shrimps, frozen shrimps, fish oil enriched frozen shrimps and fish protein hydrolysate (Gabolysat) enriched frozen shrimps during 20 days. During the rearing, enriched frozen diet maintained weight increase as in group fed on live shrimps Although the low ration observed in the group fed on fish oil enriched frozen shrimps during 20 days, the food conversion rate was as in other groups and the weight gain was better than in group fed on fish protein hydrolysate (Gabolysat) enriched frozen shrimps. From 20 to 30 days old, relative weight gain was higher and the food conversion rate was better in juvenile cuttlefish of the group fed on fish protein hydrolysate enriched frozen diet.

Trypsin and chymotrypsin were not correlated to total proteolytic enzymes activity during the growth . The juvenile cuttlefish showed the capacity to adjust phosphatase acid, trypsin and chymotrypsin activities according to different diet.

These data indicate that the quality of the diet enrichment during juvenile cuttlefish rearing depends on the age of the animal PUFA appears very important until 20 days old. They need PUFA during their youngest stage. After that age the proteins are more important in juvenile cuttlefish nutrition.

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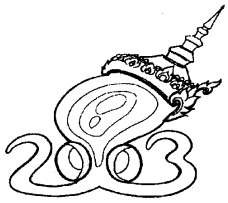
## *ARCHITEUTHIS* IN JAPANESE WATERS

From Japanese waters, two species of *Architeuthis* have been described. *A. martensi* was described by Hilgendorf in 1880 based on a large squid exhibited in the Expo in Edo (former Tokyo). Mitsukuri and Ikeda (1985) reported *Architeuthis* sp. from Tokyo Bay with a detailed description. In 1912, Pfeffer suggested that the description of *A. martensi* was too far satisfactory to identify species and gave a new scientific name, *A. japonica* to the specimen examined by Mitsukuri and Ikeda. Sasaki (1918) also reported *A. japonica* from Tokyo Fish Market. Since 1996, several damaged specimens and fragments of *Architeuthis* have been accumulated in our collection. Morphologically, three types were recognized however partial sequence of 16s and COI in mtDNA did not differ significantly. No apparent results have yet been obtained; process of the research will be introduced.

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# MANUAL FOR THE IDENTIFICATION OF CEPHALOPOD BEAKS IN THE NORTHEWESTERN PACIFIC

Beaks of fifty species of cephalopods in the northwestern Pacific have been removed from intact identified specimens. Three sets of digital photos were taken for upper beak and six sets for lower beak for each species. A data sheet, including rostral length of upper and lower beaks, dorsal mantle length, body weight, locality, registered number of specimen and nine digital photos was prepared for each species with a brief description of lower beak characteristics. An artificial key for species identification by lower beaks was constructed. Regression formulae between lower rostral length and body weight, and dorsal mantle length of 20 species were calculated and summarized in table. General recommendations for stomach contents analysis were offered for researchers on feeding habits of marine mammals, sea birds and fishes. A part of this manual in Japanese version has been accessible in the internet since 2001: http://research.kahaku.go.jp/zoology/Beak/index.html. English version is under construction.

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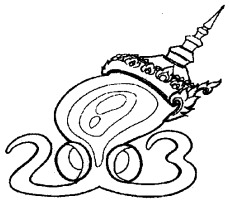


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# IMMUNOLOGICAL AND BIOLOGICAL CHARACTERIZATION OF PEPTIDES RELATED TO THE CALCITONIN GENE IN THE CUTTLEFISH *SEPIA OFFICINALIS*.

In both vertebrates and invertebrates, biomineralization implies a precise regulation of plasma calcium levels. This calcium homeostasis is regulated by various hormones. These include calcitonin, an hypocalcemic and hypophosphatemic hormone, which plays in mammals an important role in the regulation of bone formation. In vertebrates, the calcitonin gene (CALC I) encodes two main peptides: calcitonin and CGRP, the calcitonin-gene-related-peptide.
In order to understand the appearance of the calciotropic function in evolution, the presence of both peptides were investigated in various organs of the cuttlefish *Sepia officinalis*, by radioimmuno- and radioreceptor assays. The results evidenced only the presence of a single molecule in the branchial heart and digestive gland, immunologically and biologically related to CGRP. The absence of CT-like molecules was common to all other invertebrates we examined so far.
The present data strengthen the hypothesis that CGRP may be the ancestral molecule, whereas CT appeared only later in evolution.

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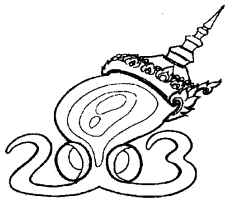


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[2]Ege University, Izmir, Turkey
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# MORPHOLOGICAL CHANGES AT MATURATION AND SYSTEMATICS IN THE SQUID GENUS *ALLOTEUTHIS*

Relative fin dimension do not allow to separate *Alloteuthis* species, as it was thought before. Smaller and younger mature animals have relatively shorter tails. At growth during long spawning period the relative size of fin increases and "*A.media*" turn out to be "*A. subulata*". Both "species" probably represent either ontogenetic or ecologic forms of the same squid.

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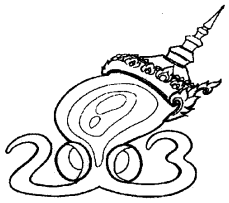


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# JUVENILE PLANKTONIC CEPHALOPODS SAMPLED OFF THE COASTS OF CENTRAL GREECE (EASTERN MEDITERRANEAN) DURING WINTER

Cephalopod early life stages were identified from plankton samples taken by bongo-net (0.500mm mesh size) around the coasts of central Greece in December 2000/ January 2001. The sampling was not directed at cephalopods but provides valuable information on the distribution of cephalopod planktonic stages in the Greek Seas. Oblique Bongo net tows were carried out on a 24hour basis at 100 stations with SST ranging 8 to 23 $^{o}$C between 200m depth and the surface. A total of 70 specimens were caught at 21 stations. Eight species of five families were recorded. Among these Ommastrephidae (77.1%) was the most abundant family followed by Octopodidae (14.3%), Loliginidae (4.3%), Sepiolidae (2.9%) and Enoploteuthidae (1.4%). Cephalopods were mostly found in stations with SST>13$^{o}$C and during evening.

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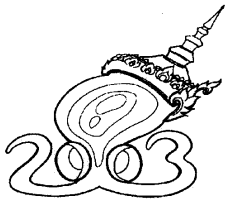


**LIPINSKI, Marek R., Christian WISSEL, Rene NAVARRO and Jose D'OLIVERA**
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# A MODEL OF LOLIGINID SQUID SURVIVAL (CEPHALOPODA: LOLIGINIDAE)

A model of loliginid squid survival, based on bioenergetic considerations, is proposed and applied to real data from the biology of *Loligo reynaudii* D'Orbigny, 1845 and *L. opalescens* Berry, 1911. In this model, probability of surviving the paralarval and early juvenile phase is a function of maximum allowed number of single efforts to capture prey (learning process), initial energy (as a yolk sac), and energy gained (food). The total survival is then determined by exploring the relationship between paralarval survival and fecundity, both in equilibrium and disequilibrium in the population. Sensitivity analysis of the model parameters is carried out. Notably, the genetic base for successful prey capture (probability of catching prey without any experience) is an important regulator of survival. According to the model, M for chokka lies between 1.82 and 1.95.

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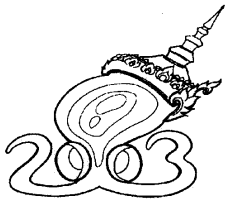
# A NEW FAMILY OF MYOPSID SQUID FROM AUSTRALASIAN WATERS (CEPHALOPODA: TEUTHIDA)

A new species of myopsid squid is described from the northern Australian and Papua New Guinea waters. The species differs from the members of Loliginidae in having a large, subcircular, funnel locking cartilage, bisected by a boomerang-shaped groove running antero-posteriorly, and a photophore of sepiolid type on the ventral surface of the ink sac. The fins of the new species are separated, not united posteriorly. There is a deep, narrow and long pocket between the arms III and IV into which the tentacular stalk can be retreated. A new family is here erected to accommodate it.

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# ODOR MIXTURE INTERACTIONS IN OLFACTORY NEURONS OF THE SQUID *LOLLIGUNCULA BREVIS.*

Coleoid cephalopods have paired olfactory organs located posterior and ventral to each eye. These olfactory organs show similarity to vertebrate noses with a neuroepithelium containing several morphologically distinct subtypes of sensory neurons, each of which sends out a single axon through a basement membrane, and a lamina propria containing bundles of unmyelinated axons which project centrally to the olfactory lobe and optic gland. Other labs have identified a number of behaviorally relevant odors for cephalopods including l-glutamate (an attractant) and betaine (a deterrent or arrestant). Perforated-patch recordings of isolated olfactory receptor neurons (ORNs) from *L. brevis* reveal that glutamate produces a cationic depolarizing receptor potential while betaine activates a chloride-mediated hyperpolarizing receptor potential. Interestingly, the same neuron is capable of responding to both glutamate and betaine. We tested whether a mixture of betaine and glutamate produced receptor potentials that could be predicted by the responses to the individual components. We found that the relative sensitivity of a particular neuron to betaine and glutamate varied from roughly equal, to mainly betaine sensitive, to mainly glutamate sensitive. During mixture applications, the observed responses were always less than the predicted, suggesting mixture interactions. The potential mechanisms underlying odor mixture interactions will also be discussed.

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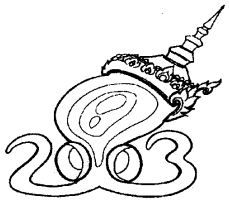


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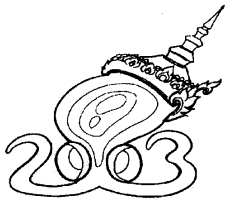
## DO SQUID MAKE A VISUAL LANGUAGE ON THEIR SKIN? AN ANSWER FOR MOYNIHAN.

In the 1980s Martin Moynihan suggested that Caribbean reef squid use display patterns on their skin to form the visual equivalent of a language. A five-year observational study of the displays of *Sepioteuthis sepioidea* in Bonaire suggests some limitations on this proposal. Some displays, notably the agonistic Zebra, the female sexual Saddle and the startle Dymantic, are variable across situations. Many displays are laterally directional and squid double signal with different lateral displays. The agonistic Zebra in males is usually an accurate index of status and can be modified to a ritualized Formal Zebra contest. The startle Dymantic uses a selection of four possible dots, but towards a potential predator and not conspecifics. Peripheral components, particularly fin colours, may emphasize a display. The Fin Base Stripe is seen with several male displays and may instead be a male identity signal. Perhaps because of the squids' simple social organization, no display or component appears to be a comment about the external environment to conspecifics. All are indications about the sender's internal state, although the Zebra can also be used deceptively. Thus despite its complexity and variability this display system does not meet all the criteria for a full language.

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# PUSHING THE LIMITS OF MULTIPLE SPAWNING: MUSCLE TISSUE DYNAMICS OF A MULTIPLE SPAWNING OMMASTREPHID SQUID *NOTOTODARUS GOULDI.*

Only two ommastrephid squid species have been described as multiple spawners and it is not known how such a reproductive strategy may affect muscle integrity that is essential to their highly mobile lifestyle. *Nototodarus gouldi* presents a unique opportunity to explore the use of mantle muscle as an energy store, and identify evidence of muscle fiber depletion during maturation which could not be ascertained at the whole animal level. This study also examines the mechanisms by which *N. gouldi* acquires its energetic needs, highlighting any trade-off in energy allocation during maturation. Females from all maturity stages were examined histologically to identify changes in fiber dynamics at three locations along the mantle and one position at the fin. Changes in circular muscle diameters for both mitochondria-rich and mitochondria-poor fibers, and muscle block size were compared between maturity stages. Preliminary results show some change in muscle fiber organization with maturation, as fibers in the inner mitochondria-rich zones of mature individuals seemed to be disappearing. If *N. gouldi* are utilizing mantle muscle as an energy store, or diverting energy away from mantle maintenance, then the energetic demands of oocyte production could be pushing the limits of a multiple spawning strategy.

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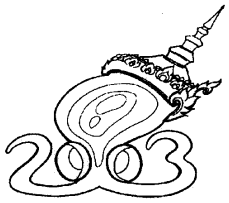


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# EFFECTS OF SEASON AND LOCATION ON THE REPRODUCTIVE STRATEGY ADOPTED BY *NOTOTODARUS GOULDI* IN AUSTRALIAN WATERS

Ommastrephid squids typically occupy broad geographic distributions as a result of their highly mobile life-style, resulting in exposure to a wide range of environmental conditions. This study explores the plastic nature of reproductive strategies in the commercially important multiple spawning ommastrephid squid *Nototodarus gouldi.* Over a two-year period, biannual samples of *N. gouldi* were taken from four locations indicative of their broadest range throughout Australian waters. A total of 2096 individuals were examined using residual analysis to determine if the reproductive strategy adopted by females depended upon geographic location or season. Younger females growing through cooler months were on average smaller, had higher gonad mass for their size, and maintained mantle mass throughout maturation. Interestingly, females from the northern limits (or lower latitudes) exhibited the highest levels of reproductive investment for their size, with GSI's approaching similar values to semelparous squids. However, as these animals were smaller in size than their southern co-specifics, these elevated GSI's did not equate to greater batch fecundity as these individuals had lower absolute gonad and oviduct weights. In contrast, southern caught females displayed the lowest levels of reproductive investment and had low oviduct weights, possibly releasing smaller batches of eggs over a longer period of time in comparison to their northern counterparts.

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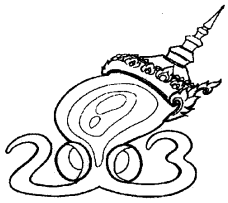


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# SMALL-SCALE SPATIAL AND TEMPORAL PATTERNS OF EGG PRODUCTION BY THE TEMPERATE LOLIGINID SQUID *SEPIOTEUTHIS AUSTRALIS*

This study estimated small-scale temporal and spatial variability in egg production by Southern calamary (*Sepioteuthis australis*) in an area known to attract spawning aggregations. Surveys of the seagrass beds (*Amphibolis antarctica*) over 14 months determined the timing and location of egg deposition, as well as estimating total egg production and loss of deposited egg masses from the spawning grounds. Egg laying in the inshore seagrass beds occurred predominantly during the austral spring and early summer. Egg production at one location was very similar between the two years, but at the second location egg production was three-fold less during the second summer. There was considerable spatial variability in egg production among seagrass beds at all scales. Variability in the use of seagrass beds by the squid during each summer was not attributed to differences in seagrass characteristics. Losses of deposited egg masses were detected on two occasions. On the first occasion the loss was correlated with storms, however, the second and smaller loss of egg masses was not correlated with storm activity. Information about the spatial and temporal patterns of egg production was used to make recommendations about the use of fishing closures to protect spawning adults from over-fishing.

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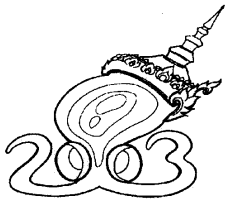


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# THE ENVIRONMENTAL INFLUENCE ON EARLY GROWTH OF SQUID FROM STATOLITH INCREMENT MEASUREMENTS

The early growth of the European squid (*Loligo vulgaris* Lamarck, 1798) in waters off the NW Portuguese coast is analysed. *L. vulgaris* exhibit a protracted spawning season, resulting in various cohorts throughout the year that are subject to very different environmental conditions. Therefore, differences in growth rates with hatching season are to be expected. Growth rates during the paralarval and juvenile stages (from hatching to the 150th day) were estimated from statolith increment measurements. Ageing of the specimens was achieved from statolith readings. To investigate the environmental influence on early growth, namely the influence of the seasonal differences in temperature, light and food availability, the growth rates of squid statoliths were compared by age groups. The growth of the paralarval and immature juvenile stages was found to be exponential, with growth rates dependent on the environmental conditions. The mean increment widths indicated that the statolith growth is slow during the first month after hatching. The maximum growth occurs with an age of 3 months for the majority of the population.

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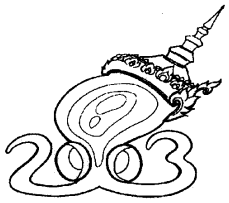


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# LIFE CYCLE OF CULTURED BOBTAIL SQUID, *EUPRYMNA HYLLEBERGI* NATEEWATHANA, 1997

The bobtail squid, *Euprymna hyllebergi*, were cultured in laboratory through 3 consecutive generations. Eggs were deposited as single egg capsules, pyramid shape with calcified chorion. The incubation period was 14.0±1.8 days at 28°C. Hatchlings were temporary planktonic and then turned benthic after 6-8 hrs. Mean mantle length was 2.20±0.04 mm and weight 0.0041 ±0.0006 g. The squids were fed on larvae and postlarvae of penaeid shrimps, mysids shrimps and larvae of goby fish during the first month after hatching. They were trained to accept chopped fish meat after that. The squids were solitary in habit and cannibalism was observed in cultured tanks. Mating and spawning was observed after about 93.9 ±12.8 days of age. One female laid 191.3±107.4 egg capsules. At the age of 100 days, mean mantle length was 22.43±0.56 mm and body weight 5.878±0.168 g. Daily growth rate from hatching to 100 days of age was 2.41 ±1.45 % by mantle length and 7.51±1.75 % by weight. Life span was average 98.9 ± 13.6 days due to death of both sexes after the last spawning

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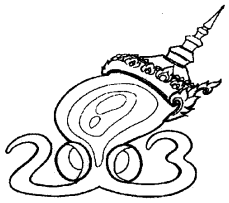


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# PERFORMANCE OF SIMPLE LARGE-SCALE CEPHALOPOD CULTURE SYSYTEM IN THAILAND

The cephalopod culture system is simplified in order to reduce the cost of production. The open water system is considered to be the less intensive supply. The size, shape and colour of concrete tanks in the hatchery are designed from experience to suite to the cephalopod habit and other purposes as well. The culture protocol consists 4 phases, egg and spawner collection, egg incubation, nursing and grow-out phases. The management techniques of the large-scale aquaculture have been employed. Thirteen species of neritic cephalopods are maintained, reared and cultured in the system, 3 loliginids, 5 sepioids and 5 octopoids, serving the research activity and seed releasing for restocking program. Four species are cultured through the complete life cycle and yielded consecutive generations. About 2.1 million seeds are annually released for restocking during the year 1990-2000. The conceptual system design of the commercial scale is proposed as five components. The components are the cephalopod hatchery, the live food hatchery, the artificial feed plant, the grow-out facilities and the artificial spawning reef.

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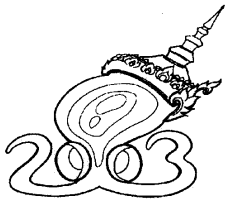


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# PYGMY CUTTLEFISH *IDIOSEPIUS PARADOXUS* (ORTMANN, 1888) (CEPHALOPODA) - FIRST RECORD OF IDIOSEPIDAE IN RUSSIAN SEAS

Photos of a pygmy cuttlefish were made near the Furugelm Island (Russia, Japan Sea, 42°28' N, 130°55' E), over the sandy bottom with seagrass *Zostera*, depth ~3-4 m, temperature ~20-22°C. The photographed and then released specimen was identified as an adult *Idiosepius paradoxus* (Ortmann, 1888). Being released it sat on a leaf of *Zostera*, grasped a mysid, ate it and swam away. Total length of animal seating on a leaf (tentacles drawn in) and when throwing on a prey (with tentacles extended) were assessed at 32 and 40 mm, respectively, the estimated mantle length was ~20-23 mm. This was the first record of a species of this mostly tropical-subtropical family in the Russian seas. The Furugelm Island is the northernmost outskirt of the species' range along the Asian coast. Supposedly, *I. paradoxus*, that normally inhabits much more southern areas, had migrated along the Korean coasts to the north, and entered the Russian waters. This may be a result of the warming up of surface waters in the Peter the Great Bay during recent years. The free-floating planktonic paralarvae and the ability to swim actively over the bottom and at the surface significantly facilitate dispersion capability of *I. paradoxus* along the shorelines.

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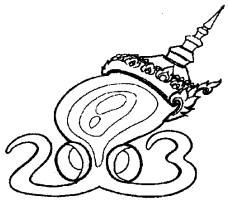


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# REVISITING OLD IDEAS IN THE LIGHT OF NEW INVESTIGATIONS: THE EVOLUTION OF BACTERIOGENIC LIGHT ORGANS IN CEPHALOPODS

Bioluminescence is widespread among many different types of marine organisms. Metazoans contain two types of luminescence production: bacteriogenic (symbiotic with bacteria), or autogenic, via the production of a luminous secretion or the intrinsic properties of luminous cells. Several species in two families of squids, the Loliginidae and the Sepiolidae (Mollusca: Cephalopoda) harbour bacteriogenic light organs that are found central in the mantle cavity. These light organs are exceptional in function, that is, the morphology and the complexity suggests that the organ has evolved to enhance and direct light emission from bacteria that are harboured inside. Although light organs are widespread among taxa within the Sepiolidae, the origin and development of this important feature is not well studied. We have compared light organ morphology from several closely related taxa within the Sepiolidae and the Loliginidae, as well as combining molecular phylogenetic data using 3 loci (nuclear internal transcribed spacer region, and the mitochondrial 12S and 16S) to determine whether this character was an ancestral trait that was repeatedly lost among both families, or whether it has evolved independently as an adaptation to the pelagic and benthic lifestyles. By comparing other closely related extant taxa that do not contain symbiotic light organs, we have hypothesized that the ancestral state of sepiolid and loliginid light organs most likely evolved from part of a separate accessory gland open to the environment that allowed colonization of bacteria to occur and further specialize in the eventual development of the modern light organ.

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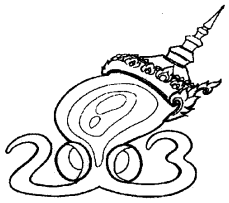


**NOOTMORN, Praulai, Sichon HOIMUK, Durongrit KEAWKAEW and Wanlee SINGTONGYAM**
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# SPECIES DIVERSITY, ABUNDANCE AND COMMUNITY STRUCTURE OF CEPHALOPODS OFF PHANG-NGA BAY AND ADJACENT AREA, THAILAND

Investigation on cephalopods off Phang-nga Bay and adjacent area, Thailand, has been conducted during March to June, 1999. Species of four families of cephalopods were recorded, namely Loliginidae (*Loligo duvauceli*, *L. chinensis*, *L. edulis, Loliolus sumatrensis* and *Sepioteuthis lessoniana*), Sepiidae (*Sepiella inermis*, *Sepia aculeata*, *S. pharaonis, S. lysidas, S. recurvirostra* and *S. brevimana*), Sepiolidae (*Euprymna stenodactyla*), and Octopodidae (*Octopus* spp.). The average catch rate and biomass were 2.61 kg $h^{-1}$ and 2 7 7 t, respectively. Species distribution and the length-weight relationship of cephalopods have been reported and discussed in the present study. The highest catches were in May (4.81 kg $h^{-1}$, 274 t), March (2.65 kg $h^{-1}$, 277 t) and June (1.65 kg $h^{-1}$, 180 t). Three assemblages could be demonstrated by using diversity analysis: the west coast of Yai Island, the nearshore stations and off-shore stations. Temperature, salinity and depth were the best-fitting parameters in correlations with biotic patterns in the studied area.

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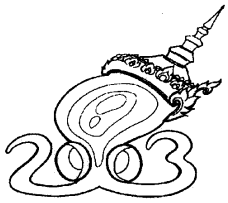


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# SPECIES DIVERSITY, ABUNDANCE AND COMMUNITY STRUCTURE OF CEPHALOPODS OFF UPPER PART OF ANDAMAN COAST, THAILAND

The cephalopod fauna off the upper part of Andaman Coast, Thailand, was investigated in April 2000. Species of four families of cephalopods were recorded, namely Loliginidae (*Loligo duvauceli*, *L. chinensis*, *L. singhalensis, Loliolus sumatrensis* and *Sepioteuthis lessoniana*), Sepiidae (*Sepiella inermis*, *Sepia aculeata*, *S. pharaonis, S. lysidas* and *S. brevimana*), Sepiolidae (*Euprymna stenodactyla*) and Octopodidae (*Octopus* spp.). The average catch rate and biomass were 7.65 kg $h^{-1}$ and 1,063.34 t, respectively. Species distribution and length-weight relationships of cephalopods have reported and discussed in the present study. Three assemblages were demonstrated by using diversity analysis: the upper part of Ranong Province, the lower part of Ranong Province and the upper part of Phang-nga Province. Salinity was the best-fitting parameter in correlations with biotic patterns in the studied area.

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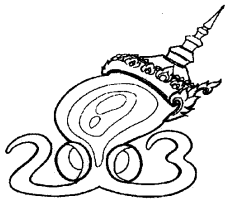


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# BIOLOGY AND ECOLOGY OF *PHOTOLOLIGO ETHERIDGEI* AND ITS APPLICATION TO THE MANAGEMENT OF SQUID FISHERIES IN NSW, AUSTRALIA

The sustainable management of any fishery is reliant on there being an adequate knowledge of the factors affecting the target species. Few species of commercially important squid have been studied in enough detail to enable effective management of their fisheries. In New South Wales, trawl fisheries that operate in the Hawkesbury River produce half the landed squid in NSW. Fishing effort and catch in the Hawkesbury River have increased in the last ten years. Despite this, there are few controls of squid fisheries in NSW and few data to make managerial decisions. This study concentrates on the biology and ecology of the squid *Photololigo etheridgei* Berry, 1918 in the Hawkesbury River.

To apply rational managerial strategies, there must be some knowledge of size and structure of populations, life-history characteristics and causes and rates of migration and mortality. This information will allow assessment of the effectiveness of potential strategies for managing this fishery, such as spawning closures.

Developing methods to study small fisheries requires an appreciation of the strengths and weaknesses of fishery data. Methodologies are being developed to study small fisheries where resources for research are limited.

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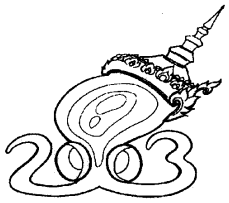


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# SPATIAL AND TEMPORAL ASPECTS OF CHOKKA SQUID *LOLIGO VULGARIS REYNAUDII* BIOLOGY ON THE AGULHAS BANK, SOUTH AFRICA.

The chokka squid, *Loligo vulgaris reynaudii,* is a commercially important species supporting a large, high-value export fishery for South Africa. This study reviewed its population dynamics and reproductive biology. Biological information collected on biannual research cruises from September 1986 to April 1999 on the Agulhas Bank as well as information from commercial vessels operating in the inshore environment collected between April 1988 and July 1989 and again between June 1999 and May 2000 were analysed.

Size ranges of juveniles, subadults and adults were calculated and used to determine seasonal distribution and abundance patterns. Based on Gonadosomatic Indices (GSI) and percentages of mature squid in each month, two peak reproductive seasons in summer and winter were identified although mature squid were present all year round. Seasonal peaks in sex ratio were also apparent with males outnumbering females by up to 4:1 in the peak-breeding season. The size at which squid matured, demonstrated both spatial and temporal patterns. Squid caught in spring matured at a smaller size than squid caught in autumn and at successively smaller sizes from west to east across the Agulhas Bank. Size at maturity was highly variable especially in males where "sneaker males" were evident in both seasons. Length-to-weight linear regression revealed significant differences between maturity stages and between sexes. Females demonstrated steeper length-to-weight regression slopes than males in the peak-breeding seasons.

Aspects of squid biology pertinent to fishery management were highlighted as well as potential areas where research should be directed in order to develop future stock assessment models.

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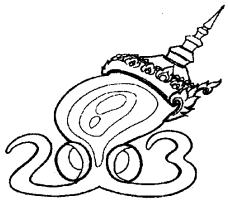


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# THE CEPHALOPOD MANTLE AS AN ENERGY STORE: USING THE 'MINI-MAXIMALIST' *IDIOSEPIUS* AS A MODEL

Cephalopods have very little in the way of lipid or glycogen stores, so it has been suggested that protein in muscle tissue serves as an energy store. By examining the size frequency distribution and organization of muscle fibres and muscle blocks in individuals subjected to different nutritional regimes (*ad-lib*, low-food and starvation) we achieved an understanding of where in the mantle (anterior, mid, posterior) reserves are mobilized from and from which muscle fibres. After seven days animals in the low food treatment had more small fibres in all mantle areas compared with control individuals, and had smaller muscle blocks at the anterior and mid mantle, suggesting fibres may have atrophied as a result of nutrient mobilisation. Severe disorganisation of posterior muscle in some low-food and all starved animals suggested resources are mobilised preferentially from this region – mobilising resources posteriorally would have the least effect on movement and therefore survivorship. Mitochondria-rich fibres appeared to be conserved in all low-food and starved animals. This selective pattern of resource utilisation indicates *Idiosepius* has control over these processes. Examination of a starved individual that was sacrificed three days after re-feeding suggested the rate of regeneration is extremely rapid. This study demonstrates that alterations in the dynamics of the muscle tissue may therefore provide a tool to assess the effect of nutrition on growth. The cellular growth mechanism of cephalopods are extremely plastic and capable of modification to meet changing requirements of the individual.

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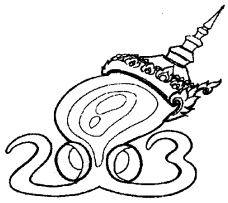


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# INTER-ANNUAL CHANGES IN POPULATION STRUCTURE AND LIFE-HISTORY CHARACTERISTICS OF A TEMPERATE SQUID : ENVIRONMENT OR EFFECTS OF FISHING?

Population structure, growth rate, condition, and reproductive output will respond to environmental factors, particularly in short-lived and fast growing squid species. Inter-annual variability in the position of convergence between nutrient rich sub-antarctic waters and warmer nutrient poor sub-tropical waters off the east coast of Tasmania, make this region highly dynamic and an ideal area to study environmentally induced population variability. Populations of *Sepioteuthis australis* were examined over four years: 1995, 1996, 1999, and 2000. An increase in water temperature was evident over this period, as well as substantial development of a targeted seasonal fishery. Inter-annual changes were evident in both the life-history characteristics of individuals and the population structure. There was a reduction in reproductive investment in both males and females, average size of individuals and weight-at-length increased, males became more prevalent in the population, and growth rates became more variable. In addition to temperature changes, the timing of peak production and food availability may have also varied between years. We explore the changes in life history characteristics as a function of selection pressure due to a sudden increase in exploitation, and changes in environmental conditions.

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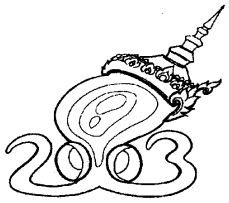


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# NON-CONVENTIONAL METHOD TO IMPROVE ESTIMATION OF LPUE FROM ARTISANAL OCTOPUS FISHERIES IN PORTUGAL

In Portugal the common octopus *Octopus vulgaris* is fished by octopus-directed artisanal fisheries operating with a multitude of gear types and by the least contribution of industrial bottom trawlers. There being no credible source of total effort or catch for the artisanal-sourced landings, management of the fishery cannot solely rely on trawler log-books. To produce a more reliable abundance index, individual (per-boat) daily landings as recorded by the official auction mediator are analysed. Instead of computing a kg-landed-per-day abundance index, which wouldn't reflect the complexity of the fishery, a procedure was devised to create a standardisation index that can reflect the effort of each boat, all individual characteristics considered. Principal assumptions are: 1) each boat's fishing capacity does not significantly change over a year; 2) each boat deploys full effort at all times; 3) there are no rejections to sea. The procedure involves stepwise calculations on "second-daily" individual landings, from which unitless standardisation indices are computed. These are combined into a standardised index for the whole fleet, which is then multiplied by the traditional LPUE, worked out from "second-daily" landings rather than all landings. The resulting LPUE (kg/day/standard vessel) is believed to be a better abundance index than simply kg/day.

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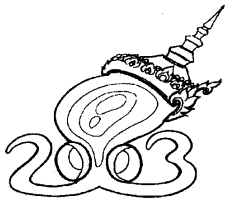


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# DISTRIBUTION OF SOME CEPHALOPOD SPECIES ALONG THE CATALAN COAST (NW MEDITERRANEAN)

The distribution of 4 Cephalopod species (*Alloteuthis media, Loligo vulgaris, Illex coindetii* and *Eledone cirrhosa*) has been analysed along the Catalan coast (NW Mediterranean). Data from experimental trawl catches from 1981 and 1991 were gathered for comparison purposes considering seasonal scale in terms of kg per haul hrs. Both temporal and spatial scales were plotted in order to have a thorough analysis of specie's distribution pattern. Georeferenced biomass indexes were extrapolated along the fishing area using kriging technique in order to have an estimation of biomass by fishing grounds. During 1981 most species abundances (*Eledone cirrhosa* and *Loligo vulgaris*) were significantly higher with respect to 1991. *Alloteuthis media* and *Illex coindetii* maintained a similar level during both studied periods. Some differences among seasonal distribution were found, for example, *Eledone cirrhosa* showed highest abundance during springs along the northern area, decreasing to its lowest level in autumns. *Illex coindetii* showed its highest during spring. Meanwhile, *Alloteuthis media* was higher during summer along the central area and *Loligo vulgaris* showed a similar seasonal pattern along the southern area.

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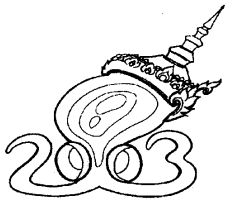


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# TEMPORAL VARIATION IN THE DIET OF THE ONYCHOTEUTHID *MOROTEUTHIS INGENS* AT MACQUARIE ISLAND ASSESSED USING FATTY ACID DIETARY TRACERS

The subantarctic squid *Moroteuthis ingens* was collected from Macquarie Island (54°30' S - 158°55' E) over four sampling periods between January 1995 and June 2000. Stomach contents and fatty acid profiles of the digestive gland were used to assess temporal variations in the diet of *M. ingens*. It was difficult to infer dietary patterns from stomach content data as few comparable data existed between sampling periods. However, fatty acid analyses of the digestive gland indicate that the diet of *M. ingens* is subject to interannual and interseasonal variations at Macquarie Island. The diet of *M. ingens* was less similar during the 1999 summer compared to the 1995 and 2000 summer; this is possibly related to warmer sea surface temperatures and decreased primary production during the 1999 summer which had affected the diet of *M. ingens*. Discriminant analysis of fatty acid data could determine whether a squid was collected during a summer or winter with an accuracy of 100%. Both fatty acid and stomach content data suggest that certain key myctophid species such as *Krefftichthys anderssoni* are not available to *M. ingens* during winter, as has been reported for other marine predators in the subantarctic Southern Ocean.

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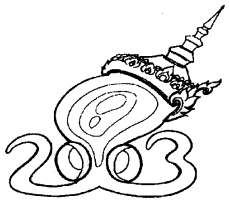


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## SYMBIOTIC ASSOCIATION BETWEEN SOME CEPHALOPODS AND THE *ROSEOBACTER* BACTERIA STRAIN.

Among cephalopods, loliginds, sepiids and sepiolids are known to possess accessory nidamental glands hosting various strains of symbiotic bacteria. The role of this association is still not yet clearly understood. The analysis of the bacteria associated to accessory nidamental gland of various cephalopod species revealed that one strain, *Roseobacter*, is common to most loliginids, sepiids and sepiolids accessory nidamental glands studied so far. *Roseobacter* strains are investigated by sequencing of bacteria 16S DNA and by in situ hybridisation (FISH) in various cephalopod species. The sequences are compared and analysed phylogenetically. Differences among sequences might be related to cephalopod groups, and eventually with geographical distribution. The results are discussed in relation with the taxonomy and phylogeny of cephalopods.

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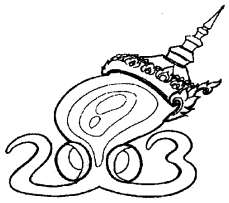


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# INTERANNUAL VARIATION IN LIFE-CYCE BIOLOGY OF *LOLIGO FORBESI* IN SCOTTISH (UK) WATERS

The loliginid squid *Loligo forbesi* has a flexible life-cycle, involving variable size and age at maturity, presence of summer and winter breeding populations, and extended periods of breeding and recruitment. This paper reviews life history data collected since 1985 from the commercial fishery in Scottish (UK) waters and examines (a) the relationship between hatching month and age, size and timing of maturation, (b) shifts in the relative abundance of the summer and winter breeding populations, and (c) the role of environmental signals in determining the timing of breeding.

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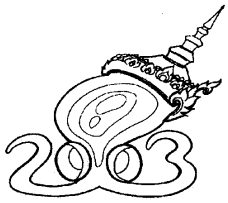


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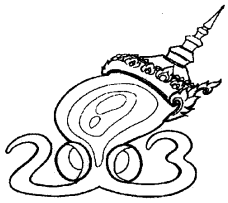
# GROWTH OF THE NORTH PACIFIC GIANT *ENTROCTOPUS DOFLEINI*

Our study examines the growth rates of *Entroctopus dofleini* over its life cycle from egg to maturity. Cephalopod growth, which is heavily influenced by food availability, behavior and temperature, remains un-modeled. To determine the energy expenditure and the growth potential over the lifespan of *E. dofleini*, we have used various methods, including measuring oxygen consumption, behavior monitoring, recapture efforts and feeding experiments to create a work-in-progress growth rate chart that will hopefully be of use as we contend with a subject that is still shrouded in mystery.

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# COULD POOR RECRUITMENT IN THE SOUTH AFRICAN CHOKKA SQUID FISHERY (*LOLIGO VULGARIS REYNAUDII*) BE CAUSED BY OFFSHORE LOSSES OF PARALARVAE?

The South African squid fishery experiences highly variable biomass and catches. Periods of poor recruitment are thought to contribute towards this. The potential offshore loss of paralarvae from the Agulhas Bank ecosystem into the faster flowing Agulhas Current maybe a factor responsible for poor recruitment. Results of several current measurement studies on the Agulhas Bank have now enabled an understanding of the shelf circulation to be acquired, and thus a theoretical depiction of squid paralarval transport. Much to our surprise, it appears that paralarvae are transported for much of the time (70%) to the east of the spawning grounds where the Agulhas Current is dominant and offshore transport has been shown to exist. This is opposite in direction to our present understanding of the life cycle and appears to be a high risk life strategy. To test this, several satellite tracked drogues were released. These demonstrated that paralarvae commonly found in the surface layer, can be lost from the Agulhas Bank ecosystem. A Regional Ocean Modelling System (ROMS) was then used in an attempt to quantify paralarvae transport, loss and variability of these parameters. An IBM (model) was coupled with ROMS in which 1000ˆs of *paralarval particlesˆ where released in the ocean model and their movement tracked. This showed that some paralarvae in the Agulhas Current can be returned to the shelf via a semi-permanent shelf edge eddy.

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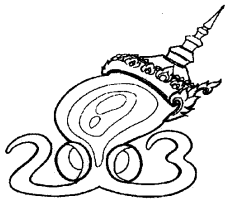


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# DESCRIPTION OF A NEW SPECIES OF *UROTEUTHIS (PHOTOLOLIGO)* FROM THE MOZAMBIQUE CHANNEL

A new species of photogenic loliginid is described from the Mozambique Channel. The animals mature at a small size (mantle length 60 mm) and are apparently close to *Uroteuthis pickfordae* from Indonesia. They differ consistently, however, in details of sucker dentition, hectocotylus morphology (relative length of modified distal part of arm, number of proximal suckers, shape of proximal papillae) and relative arm, club and fin lengths.

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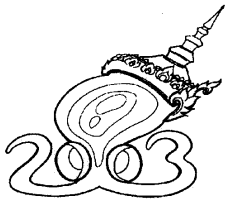

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# SPATIAL-TEMPORAL CHANGES IN DIMETHYL ACETAL (OCTADECANAL) LEVELS OF *OCTOPUS VULGARIS* (MOLLUSCA, CEPHALOPODA) : RELATION TO FEEDING ECOLOGY

The present study was aimed to quantify the dimethyl acetal (DMA) levels in *Octopus vulgaris* muscle and investigate the possible influence of octopus' feeding ecology in their spatial and seasonal variations. The research was performed over one-year period in three areas of the Portuguese coast: Viana do Castelo, Cascais and Tavira. Significantly higher values of DMA in octopus muscle were detected in Tavira ($p<0.05$), an area where the importance of bivalves in the octopus' diet was higher. The biochemical analyses performed in several prey items, belonging to five major taxonomic groups identified in octopus' stomachs, revealed significant differences in DMA levels ($p<0.05$). The higher values were obtained in bivalves (1.15 mg/100g dw), followed by gastropods (0.74 mg/100g dw), cephalopods (0.67 mg/100g dw), crustaceans (0.23 mg/100g dw) and osteichthyes (0.10 mg/100g dw). Therefore, the higher DMA levels in *O. vulgaris*, obtained in Tavira throughout the year, could be an evidence of its feeding ecology. Since DMA's are derived from plasmalogens (PLM), and since PLM may be a component based on the environmental and physiological conditions, the significantly different DMA levels obtained in *O. vulgaris* and preys may be related with their different life histories.

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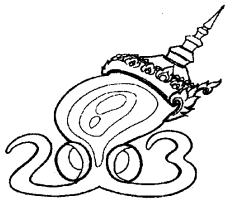

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# RECRUITMENT SPATIAL PATTERNS AND MIGRATORY EXCHANGES IN ENGLISH CHANNEL LOLIGINID SQUIDS DESCRIBED WITH SPATIAL COHORT ANALYSIS

English Channel squid resource (ICES divisions VIId and VIIe) consist of two loliginids species, *Loligo forbesi* and *Loligo vulgaris*, which show different spatial distribution. Stocks are almost exclusively exploited by French and British fleets and fishery statistics are available on an ICES rectangle basis. A spatialized assessment method, Spatial Cohort Analysis, is applied to a series of monthly cohorts in both stocks (1993-1997). This method is based on simple hypotheses and uses fishery statistics by zone and results of the Cohort Analysis developed at the scale of the whole English Channel stocks. Abundance and fishing mortality estimates are computed for each spatial box (groups of rectangle). These boxes are determined with multivariate analysis (correspondence analysis and clustering) from monthly GLM abundance indices per statistical rectangle. Results provide a description of the spatial distribution of recruitment, seasonal abundance and fishing pressure. Also the method enables evaluation of migratory balances, in number of animals, between zones.

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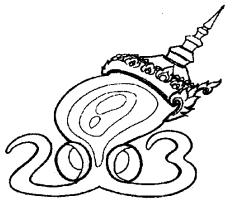


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# AGE AND GROWTH OF *OMMASTREPHES BARTRAMI* PARALARVAE IN THE NORTH PACIFIC WITH A SPECIAL REFERENCE OF TEMPERATURE EFFECT FOR THE AUTUMN COHORT

The ommastrephid squid *Ommastrephes bartrami* distributes worldwide in subtropical-temperate oceanic waters. In the central North Pacific, the autumn cohort of the species has been commercially harvested. We examined 140 paralarvae of this cohort collected from an inferred spawning ground of the northern waters of Hawaii in the North Pacific during November to December 2001. The paralarvae distributed from 20 to 25 ℃ in SST. The paralarval age was determined from growth increments of statoliths and compared with growth lines in the lateral wall of the upper beaks. We examined the growth increments in beaks of the known age with artificially reared hatchlings. There was a good coincidence of the growth increments between statoliths and upper beaks. We divided the paralarvae into two groups from warmer and cooler waters, and then determined age and DML relationship in each group. Daily growth rate of paralarvae from warmer waters was apparently higher than that from cooler waters. Both growths were expressed as exponential curves. The growth analysis suggested that the slight difference of temperature would produce larger difference in early growth of this species.

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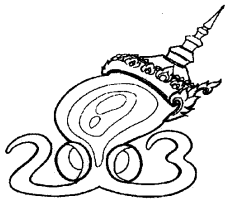


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# EMBRYONIC DEVELOPMENT AND MORTALITY OF *ILLEX ARGENTINUS* AS A FUNCTION OF TEMPERATURE: A POSSIBILITY OF THE SPAWNING ALONG THE MALVINAS CURRENT

Embryonic development and mortality for artificially fertilized eggs of the Argentine shortfin squid *Illex argentinus* were examined as a function of water temperature in vitro. We set several temperature units, 8.5 to 26.0 ℃, to incubate the eggs, and observed duration of the embryonic development and normal hatching rate in each temperature unit. Duration from fertilization to the hatching stage varied 100 hours at higher temperature (26 ℃) to 550 hours at lower temperature (10 ℃). In the course of the development, embryonic mortality including abnormal hatching was high under 10 ℃ and over 25 ℃. Higher survival was observed between 15 to 23 ℃. These indicate the velocity of the embryonic development and mortality should be determined by water temperature. The experimental results were applied for a simple simulation considering several oceanographic and biological parameters to verify the egg masses transport's hypothesis for the South-Patagonisn Stock (SPS). The result suggests that there remains a slight possibility that the egg masses spawned along the Malvinas Current could reach the Brazil-Malvinas Confluence and could hatch out there.

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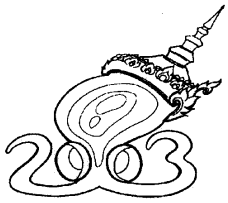


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# OBSERVATIONS ON POSSIBLE EGG MASSES OF THE SQUID, *TODARODES PACIFICUS* IN THE SEA OF JAPAN

Ommastrephid squids generally produce large numbers of small eggs encapsulated in gelatinous masses. No egg masses have been observed in the natural habitat, but they are thought to occur within the pycnocline, based laboratory observations on spawning of captive squid. During 1998-2002, MOCNESS and an ROV were used to examine the distribution of egg masses and paralarvae of *Todarodes pacificus* in the Sea of Japan near the Oki Islands, a known spawning ground of this species. In November 2000, the MOCNESS was used to sample at 21 stations through 5 depth layers between 0-100 m depths. Hatchlings occurred in the surface layer (0-25 m depth) and larger paralarvae were distributed through a wide depth range. The ROV was used at 7 stations to search for egg masses near the pycnocline (70-120 m depth). Gelatinous structure resembling egg masses were observed at two stations in the Tsushima Current along the continental shelf off the Oki Islands. They occurred within the pycnocline (75 and 95 m depth, respectively), where temperatures were about 18 ℃, and the sigma-T value was 24.5. Temperatures in the pycnocline are suitable for embryonic development, and the risk of predation and mechanical damage to egg masses is presumably lower than at the surface. Upon hatching, paralarvae may rise to the surface layer, where they would be carried into the convergent frontal zone in the Tsushima Current.

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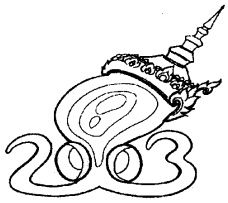


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# STOCK FLUCTUATIONS OF JAPANESE COMMON SQUID (*TODARODES PACIFICUS*) RELATED TO THE WINTER MONSOON

In short-lived squids, recruitment success most likely depends on the physical and biological environments at the spawning and nursery grounds. Annual catches of Japanese common squid, *Todarodes pacificus*, in Japanese and Korean waters have markedly increased since the late 1980s, and recent catches have equaled those of the 1960s. A previous study (by YS) suggested that the winter spawning area of *T. pacificus* in the East China Sea shrank when adult stocks decreased during a cool regime that occurred before 1988, and that its fall and winter spawning areas extended and overlapped in the Sea of Japan and East China Sea when adult stocks increased during a warm regime that occurred after 1989. Another study (by JY) suggested that successful hatching from egg masses is higher when the mixed layer depth (MLD) is shallower than the bottom depth. In the present study, we examined the relationship between annual catch of the winter-spawning stock, and wind speed and air temperature in the East China Sea in February during 1980-2000 to determine how a series of calm and warm winters might promote a stock increase related to changes in the MLD. We show that annual catches markedly increased during a decade of weak wind speed and warm air temperature from the mid-1980s to mid-1990s, suggesting that the strength of winter wind stress affects the winter-spawning stock fluctuations in *T. pacificus*.

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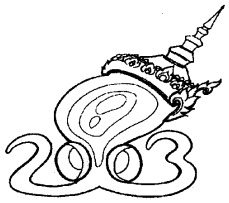


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# CONTAMINATION OF HEAVY METALS IN CEPHALOPODS ALONG THE EASTERN COAST OF THE GULF OF THAILAND DURING 1999-2000

Study on contamination of heavy metals in mantle flesh of cephalopods along the Eastern Coast of the Gulf of Thailand from Samaesarn Strait, Chonburi Province to Trat Province, Thailand, were conducted during 1999 to 2000. One hundred and seventy nine specimens of four groups of cephalopods (*Sepia pharaonis, Sepioteuthis lessoniana, Loligo* spp. and *Octopus* spp.) were collected by bottom otter-board trawlers from 15 sampling stations. Total mercury was determined by cold vapor technique equipped with mercury detector after pre-concentrated on gold particles. Cadmium, copper, zinc and iron were determined by atomic absorption spectrophotometer equipped with graphite furnace and flame. The average concentrations of total mercury, cadmium, copper, zinc and iron were 0.04, 0.66, 17.29, 55.00 and 37.29 μg/g dry-weight, respectively. The weekly dietary intakes of mercury and cadmium of Thai populations through the consumption of cephalopods were 15.96 and 263.34 μg/person/week, respectively. However, the concentrations reported here were lower than the food contamination standard criterion and also safe for consumption.

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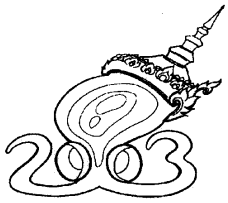


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# NICHE OVERLAP IN TEUTHOPHAGOUS WHALES IN THE NE ATLANTIC

Sperm whale (*Physeter macrocephalus*), Northern bottlenose whale (*Hyperoodon ampullatus*) and Cuvier's beaked whale (*Ziphius cavirostris*) are oceanic cetaceans known to feed mainly on deep-water cephalopods. Since these whales coexist in the NE Atlantic it is of interest to determine the extent to which their feeding niches overlap or whether there is resource partitioning. We analysed stomach contents of the three species from the Northeast Atlantic to test the hypothesis that northern bottlenose whale and Cuvier's beaked whale, both being considerably smaller than sperm whales, would take smaller squid.
Samples consisted of stomach contents of 22 sperm whales, 6 northern bottlenose whales and 3 Cuvier's beaked whales stranded in Scotland, Denmark, The Netherlands, Ireland and NW Spain. The oceanic squid *Gonatus* sp. (probably *G. fabricii*) was the main prey of both sperm and northern bottlenose whale, whereas *Gonatus* sp. and another oceanic squid *Teuthowenia megalops* were the most frequent prey of Cuvier's beaked whale. The maximum size of *Gonatus* eaten by the three species of whale was similar, perhaps reflecting the maximum available. However, while sperm whales had eaten almost exclusively mature squid, the stomachs of bottlenose whales also contained smaller post-juvenile individuals. Cuvier's beaked whale took the widest range of sizes of *Gonatus* sp., including both adults and juveniles. Juvenile *Gonatus* are found near the surface whereas post-juvenile (and mature) individuals are found in deeper waters. This could indicate that *Z. cavirostris* feeds in shallower waters than is normally the case for either sperm or northern bottlenose whale.

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# SQUID PREY OF SALMON IN THE NORTHEAST PACIFIC

The distribution and growth patterns of the gonatid squids *Berryteuthis anonychus* and *Gonatus middendorffi* collected from salmon stomachs are described. Salmon were collected in the Gulf of Alaska between 47 and 56ºN during June-July 2001. Squids were most abundant in the stomachs of coho and sockeye salmon *B. anonychus* mantle lengths ranged 50-100 mm ML and increased slightly from south to north; *G. middendorffi* mantle lengths ranged 5-70 mm and showed no latitudinal trend. *B. anonychus* was the most abundant squid prey south of 52ºN in the Subarctic Current, and *G. middendorffi* was the most abundant squid prey north of this latitude in the Alaska Gyre. These results suggest that the distribution patterns of *G. middendorffi* and *B. anonychus* are correlated with oceanographic features in this region. These and other observations will be discussed.

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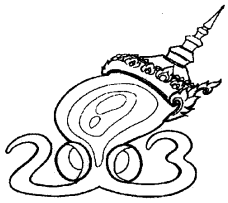


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# MANAGEMENT OF THE SQUID FISHERY IN POST APARTHEID SOUTH AFRICA

Fisheries management of finfish stocks has largely failed worldwide. In the last few decades many of the world great fisheries have gone from abundance to depletion - World fisheries are in a crisis. In contrast, management of fisheries in Southern Africa has largely been successful. In the 1980's and 1990's particularly, good science provided realistic input and output regulations – BUT good science is true for other countries whose stocks are in a dismal condition. For South Africa, management appears to have been successful largely by political default, limiting the number of players. That changed with the introduction of democracy in 1994 and the new Marine Living Resources Act (MLRA) which was promulgated in 1998, provides broad policy guidelines on fisheries management, broadening of access rights, transformation and empowerment issues. A series of interventions to the squid fishery, with profound economic, legal and political consequences were embarked upon between 1994 and 1999 without an adequate framework for understanding the expected outcomes. Initial attempts at redistribution of fishing rights resulted in litigation, controversy, appeals and a fishery in crisis. A revised process for allocation was designed, moving from an annual allocation of fishing rights to allocating medium-term 4 year fishing rights in 2002. This allocation was supported by a legal framework, industry input, economic information and outsourced administration. Medium term rights now exist for the squid fishery. Management by input control for this fishery now deserves careful review, recognising the failure of a top down management approach and the need for secure, tradable and flexible access rights and clear management goals.

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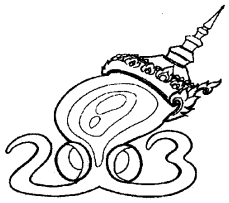


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# LABORATORY STUDIES OF THE FOOD SELECTIVITY AND DIURNAL CHANGES IN FEEDING ACTIVITY OF SQUIDS AND CUTTLEFISHES

Food selectivity and diurnal changes in feeding activity of two loliginid, two sepiolid and four sepiid species collected from the shallow coastal waters of the tip of Boso Peninsula, central Honshu, Japan, were observed in an indoor open seawater system. When the individuals were simultaneously fed with atherinid fish, gobiid fish and palaemonid shrimp in similar size, prey selectivity of the individual was depended on the species. *Euprymna morsei* ate only shrimp. Although *Sepia esculenta*, *Sepioteuthis lessoniana, Loliolus japonica* ate all the three items, *S. esculenta* and *S. lessoniana* preferred shrimp in contrast with atherinid fish for *L. japonica*. The diurnal rhythm in feeding activity was different with the species observed. *E. morsei*, *Sepia lycidas* fed actively all through the night, *S. esculenta* and *L. japonica* fed mainly at the first half of the night, and the rocky shore *Doratosepion* species fed mainly in the daytime, respectively. The diurnal rhythm in feeding activity of *S. lessoniana* showed a tendency to change from daytime feeding to nocturnal feeding with growth.

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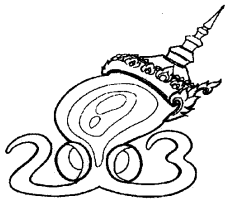


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# *IN SITU* OBSERVATIONS OF EGG-BROODING IN *GONATUS ONYX* (CEPHALOPODA: GONATIDAE) IN THE DEEP MONTEREY CANYON

*Gonatus onyx* is among the most abundant mid- to shallow-water cephalopods off the coast of California. An ontogenetic vertical migration has been described, but reproductive stages are poorly known. Recently, a deep-sea egg brooding habit was postulated for gonatid squids based on trawl-captured specimens and egg masses. The idea has been contested by some researchers. Here we present direct submersible-based observations of several female gonatids brooding egg masses at depths between 2000 and 3000 meters in the Monterey Canyon. Females hold the egg mass with the hooks on the arms and were observed protecting (through active locomotion) and aerating the egg mass. Observations of seasonality, developmental state and additional laboratory development of the eggs in some cases suggests a brooding period between 6 and 9 months in duration.

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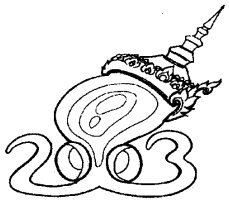


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# BIOACCUMULATION OF LEAD IN *OCTOPUS VULGARIS* TISSUES ALONG THE YEAR IN CASCAIS (PORTUGAL)

*Octopus vulgaris* (Linnaeus, Cuvier 1797) is a benthonic species with a high economic value in Portugal. Lead (Pb) is a pollutant that we have concern, and have deleterious effects in animal's health. We study the influence of season and gender in distribution and in the concentration of lead in octopus. For these study octopuses (males and females) were collected, from animals landed by commercial fishing, during the four seasons of the year at the coastal area of Cascais. Lead was determined in several tissues. We verify that the tissue which bioaccumulated more is the digestive gland where the levels can reach 26.48 g/g dry weights. The branquial heart has high levels of lead, too. The quantitative of lead in tissues was not correlated with weight, length or mature state of the animals. The quantities in different tissues were not correlated between them. The results show that there are no differences between seasons in digestive gland and in branquial heart. Octopus shows different rates of Pb accumulation between genders, especially in the digestive gland. For these results we can conclude that Octopus is a good accumulator of lead and can be responsible for its transfer to top marine predators.

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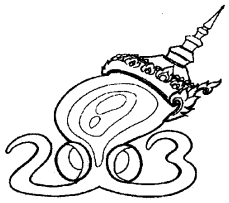


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# LIPOFUSCIN ACCUMULATION IN CEPHALOPODS: IS IT A MEASURE OF OCTOPUS GROWTH?

The most important tool needed to examine the life history of octopus and model the dynamics of their populations is an accurate ageing method. The metabolic by-product lipofuscin accumulates in nervous tissue, and in crustaceans accumulates linearly with age. The relationship between the accumulation of lipofuscin and age and growth is unknown for cephalopods. This study assessed lipofuscin as a potential ageing tool for octopus. The olfactory lobe of the brain, the stellate ganglions and arm tissue of *Octopus maorum* were examined by fluorescence microscopy of unstained histological sections to determine whether they contained quantifiable lipofuscin. All tissue types examined had large quantities of lipofuscin in discrete granules. Olfactory tissue and the stellate ganglions had the largest lipofuscin deposits; however, arm tissue still has potential for non-destructive validation of lipofuscin ageing. To define the relationship between lipofuscin accumulation and age and growth in octopus, the stellate ganglions and brain of known-age *Octopus pallidus* raised in laboratory tanks were examined. Lipofuscin levels were quantified for these known-age individuals, with preliminary examinations suggesting a possible relationship between age and the density of lipofuscin granules in nervous tissue of these octopus.

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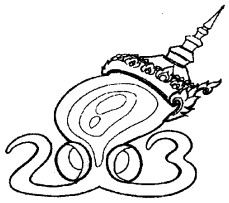


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# MOVEMENT OF *OCTOPUS MAORUM* IN RELATION TO THE UNIQUE EAGLEHAWK BAY FISHERY

Examining movement and migration patterns of cephalopods is essential for understanding population dynamics and managing their stocks. Large numbers of *Octopus maorum* move into the dead-end bottleneck of Eaglehawk Bay, Tasmania throughout the year and are easily captured by fishers. Understanding why *O. maorum* aggregate in this narrow bay is important for ensuring sustainable harvesting. Broad-scale movement of *O. maorum* was examined using curtain-arrays of passive acoustic 'listening stations', such that individually tagged octopus were identified and recorded if they moved in or out of Eaglehawk Bay. A real-time acoustic positioning system tracked octopus on a finer scale within the bay. Tagged octopus did not enter or leave the bay during the study, with most animals remaining near the tagging site. Some animals, however, did undergo large movements of up to 4km. Both real-time and passive monitoring demonstrating that *O. maorum* were night active. Some tagged octopus were caught by fishers, while others remained mobile within the fishery. All octopus captured by the fishery were mature, with 60% female. This research demonstrated that not all octopus in the region move into Eaglehawk Bay, but those that do may do so to mate and/or spawn, creating the potential for recruitment over-fishing.

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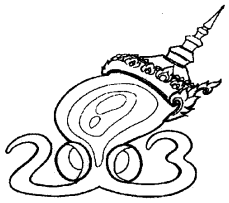


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# THE CEPHALOPODS OF THE SOUTH COAST OF PORTUGAL

Research information on cephalopod species that inhabit Portuguese waters is scarce. Most of the studies published are from late 19th century, beginning of the 20 century (Girard, 1889, 1890; Nobre, 1934). After these, only Sacarrão (1956/57) and Sousa-Reis *et al*, (1984) published about cephalopods inhabiting Portuguese waters. Other studies exist, but most were related with the biology and fisheries of high value commercial species as *Octopus vulgaris*, *Loligo vulgaris* and *Sepia officinalis*.

Since 1996, all cephalopods collected in south Portuguese waters (Algarve waters) by sampling programmes of different research projects were identified and biological parameters were registered, with the main objective of studying aspects of their biology. All specimens were collected by the fishing fleet operating in the Algarve waters within an area defined by the longitudes 7º25'W and 9º00'W, and the latitudes 37º10'N and 36º 40' N, along the south Portuguese coast.

A total of 29 species belonging to 8 families were identified. Species as *Scauergus unicirrhus, Pteroctopus tetracirrhus, Bathypolipus arcticus, Histioteuthis reversa, Abralia veranyi, Sepietta neglecta, Sepiola robusta* and *Neorossia caroli,* to the best of our knowledge, have not been recorded in Portuguese waters. Apart from the list of all cephalopods recorded in this area (commercial and non-commercial), information on depth stratification, geographical distribution, abundance and habitat assemblages are provided.

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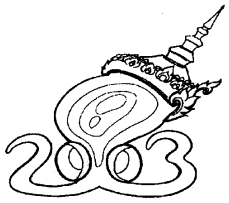


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# THE BIOLOGY OF THE MUSKY OCTOPUS *ELEDONE MOSCHATA* (LAMARCK, 1799) OFF THE SOUTH COAST OF PORTUGAL

The musky octopus *Eledone moschata* (Lamarck, 1799) was for a long time considered a Mediterranean endemic species. Today, it is known that this species is distributed in the Mediterrannean Sea, Gulf of Cadiz and south coast of Portugal. In the south coast of Portugal, the musky octopus has a considerable commercial interest, and is caught as a by-catch mostly by the trawl fleet. However, during the study period, specimens of musky octopus were also caught by purse seine. This may be due to the fact that sometimes the nets of this fishing gear touch the bottom, working as a trawl.

This study describes aspects of the population biology of the musky octopus *Eledone moschata* in the south coast of Portugal, Algarve, where, in spite of their abundance, little is known.

The specimens were collected, in a monthly sampling program, from October 1999 to October 2000. A total of 1191 specimens were sampled, of which 668 were females and 523 were males. The sex ratio of the whole population sampled was biased toward females. The sex-ratio was estimated to be 0.78:1 (male:female). The monthly evolution of maturity stages and maturity indices showed that the breeding season occurred from November to July, being February to May the most important period. Males mature at smaller size than females and mature males predominate throughout the year while mature females appeared only in very low numbers.

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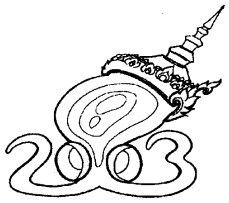


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# DNA MARKERS INDICATE THAT THE DISTINCT SPAWNING COHORTS OF PATAGONIAN SQUID (*LOLIGO GAHI*) DO NOT REPRESENT GENETICALLY DISCRETE POPULATIONS

The Patagonian squid, *Loligo gahi*, is subject to heavy fishing pressure around the Falkland Islands. Regulation of fishing pressure is based upon models that assume a single homogeneous population within these waters. *L. gahi*, however displays two temporally distinct peaks of spawning (and subsequently recruitment) each year, and geographically separate spawning concentrations around the Falkland Islands. The current study assessed, using molecular genetic markers, whether the distinct spawning cohorts or spawning sites represent genetically distinct sub-populations, in which case management models would need adjustment.

Genetic variation at 6 microsatellite DNA loci was screened in 955 individuals, representing both Spring and Autumn spawning cohorts and populations N, E, S and W of the Falkland Islands. Estimates of the component of genetic diversity distributed between samples ($F_{st}$) indicate low, and non-significant, levels of genetic differentiation. It can be concluded that *L.gahi* around the Falkland Islands comprises a genetically homogeneous, freely interbreeding population, with differences in timing and place of spawning representing continuous, within-population variation. Comparison with a sample of *L.gahi* from Peru showed distinct and highly significant differences in gene frequencies in the populations to the west and east of South America, compatible with these being distinct genetic populations, possibly of sub-specific status.

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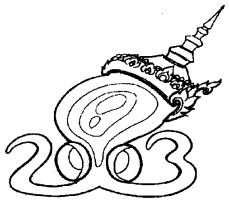


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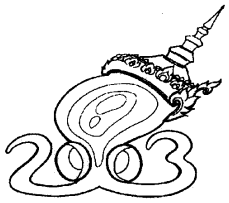
# GROSS MORPHOLOGY OF THE TENTACULAR ONTOGENY IN THREE SPECIES OF OMMASTREPHID PARALARVAE

The ontogeny of the fused tentacles of *Ommastrephes bartramii* (Lesueur, 1821), *Sthenoteuthis oualaniensis* (Lesson, 1830) and *Hyaloteuthis pelagica* (Bosc, 1802) is examined in detail, using light and scanning electron microscopy. Measurements of the fused tentacles and the developing proximal split were taken to quantitatively describe this process. In all cases, but most dramatically in *S. oualaniensis*, the proboscis initially grows beyond the third pair of arms. Immediately following separation, the proboscis may be shorter than the arms. The fused portion of the tentacles is twice the width of the proximal, post-separation tentacles. The distance between the bases of the tentacles increased throughout ontogeny.

Scanning electron microscopy of a growth series in each species shows the proboscis is not obviously strained during separation. Separation occurs from proximal to distal, without any signs of invagination along the oral or aboral edges. No evidence of tissue tearing is present at the site of splitting. The last region to separate is the proximal club. Concurrent with separation, the dactylus grows distally and adds sucker buds. Immediately after separation, some original suckers are missing, and evidence of new sucker growth is present. In total, these observations suggest a separation process that is gradual along the length of the stalk, followed by a rapid rupturing of the club.

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# EMBRYONIC BRAIN DEVELOPMENT OF THE LOLIGINIDS: AXONAL SCAFFOLD, NEUROPIL FORMATION, AND CORRELATION WITH THE EARLY LIFE STYLES

To understand the neural basis of a variety of life modes in cephalopod hatchlings and juveniles, knowledge of the brain development is important. We report morphological changes of the developing brain in *Loliolus japonica*, *Sepioteuthis lessoniana,* and *Loligo edulis*. Immunostaining of embryonic brains in *Loliolus japonica* with a neural specific marker, anti-acetylated α-tubulin antibody, reveals that a simple axonal scaffold appears in the early stages before differentiation of brain lobes, and neuropils characteristic of each lobe form later. Some longitudinal connective and commissural pathways are prominent in the axonal scaffold of the subesophageal mass. The vertical lobe system and the subpedunculate lobe differentiate last in the dorsal part of the supraesophageal mass. Comparison of the brains among hatchlings of the three loliginids indicates that almost all lobes seen in the adult brain are already present, whereas the vertical lobe is roughly proportional in size to the hatchling size among the three species. We consider how differences in brain development reflect differences in strategies in the early life of cephalopods on the basis of the present data with data from other coleoid species.

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# POSSIBLE SPAWNING BY THE SQUID *TODARODES PACIFICUS* AT YAMATO RISE IN THE SEA OF JAPAN

*Todarodes pacificus* is a commercially important squid in Japan. Its main spawning area is between the Oki Islands and near Kyushu Island, however in the present study, using squid-maturity and paralarval-distribution data, we show that spawning might also occur much further north in the Sea of Japan. Mature squid were collected at 13 stations with automatic jigging machines and by hand jigging. Paralarvae samples were collected at 12 stations using paired, 70-cm-diameter Bongo nets. One 15-min double-oblique tow was conducted at each station to about 100-m depth. The dorsal mantle lengths of collected paralarvae were measured with an ocular micrometer in a stereomicroscope. Post-spawning females were collected at the shelf and slope (bottom depths: 100-500m). At positive stations, temperatures at 50-m depth were >15℃. Spent females were collected near Yamato Rise. Paralarvae ranged from 1.0 to 6.5 mm DML. Smaller paralarvae were more abundant at Yamato Rise and off Noto Peninsula, suggesting that spawning may occur in this region during autumn.

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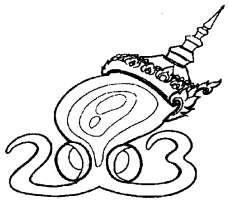


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# CONTEXT-SPECIFIC BEHAVIOURAL INDIVIDUALITY IN A SEPIOLID SQUID (*EUPRYMNA TASMANICA*) AND CORRELATES OF INDIVIDUALITY AND SQUID CONDITION

Behavioural variability is ubiquitous in natural populations of animals. However, processes that generate individual differences in behaviour and the ecological consequences of this variation remain unclear. In this study we define behavioural individuality in the southern dumpling squid (*Euprymna tasmanica*). Seventy-seven adult *Euprymna* were given two behavioural tests twice/week for two weeks simulating 'naturalistic' circumstances (*ie.* a Threat and Feeding Test), and behaviours were analyzed using a principal components analysis. Three major axes of variation (*Shy/Bold*, *Activity*, and *Aggression*) were consistently found across time, multiple methods of analysis, and test situations. However, results also indicated that behaviours within individuals were context-specific. That is, component scores for individuals along the 3 dimensions in the Threat situation did not correlate with scores obtained during Feeding tests. For example, animals that were bold in a threatening situation did not necessarily act in a bold manner in the feeding situation. From an adaptationist perspective, this context-specificity in behaviours coupled with somatic condition and reproductive status can be indicative of selective processes in the field. Understanding selective pressures on individuals is crucial to understanding an individual's resulting behavioural ecology.

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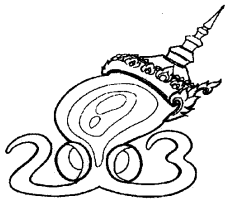


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# EXPLORATION OF PURPLEBACK FLYING SQUID, *STHENOTEUTHIS OUALANIENSIS* RESOURCES IN THE WATERS OF SOUTHEAST ASIAN REGION

The survey objectives were to investigate distribution and abundance of the purpleback flying squid, *Sthenoteuthis oualaniensis* and its fishing ground conditions. The survey areas covered in the South China Sea, Western Pacific Ocean and Andaman Sea. Automatic squid jigging machines with luring light system were employed for collecting the squids. A total of 44 sampling and 144 oceanographic stations were explored in summer from 1998-2002. A total of 4,736 *S. oualaniensis* specimens consisted of 2,592 specimens from the Western Philippines, 1,412 specimens from the Vietnamese waters, 253 specimens from the Sabah, Sarawak (Malaysia) and Brunei Darussalam waters, 380 specimens from Andaman Sea and 99 specimens from Western Pacific Ocean (Eastern Philippines). Mantle-length ranges of the *S. oualaniensis* captured specimens were 90-250, 90-240, 58-230, 70-295 and 90-235 mm, respectively. CPUEs of the *S. oualaniensis* ranged 0.15-18.47 squid/line-hour. *S. oualaniensis* were abundant in waters off Currimao and San Fernando, Philippines (17˚-18˚N and 117˚-119˚E) and off Danang, Vietnam (15˚N and 111˚E). Angling depth where the squid were densely found ranging from 50 to 100 m. Drop-off rates for jigs fished by the jigging machines were up to 0.33 squid/line-hour. The oceanographic data analysis revealed that the *S. oualaniensis* distributed in the warm water mass whereas the sea temperature ranged 14-31˚C within the depth of 150 m up to the sea surface at night. Good fishing grounds of the *S. oualaniensis* were at the area of 17˚N, 117˚E and 18˚N, 119˚E, nearby the seasonal upwelling areas. Another upwelling was also observed in Vietnamese waters at 14˚N, 111˚E during May.

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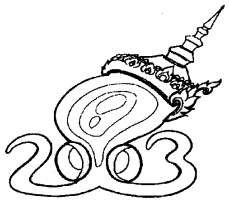


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# METABOLIC PROFILE AND ODOR RESPONSIVENESS OF SQUID OLFACTORY NEURON SUBTYPES

The squid olfactory organ consists of five olfactory receptor neuron (ORN) types characterized by their morphology. We determined the metabolic profiles of the cell types using amino acid specific antibodies, so we could assay the odor responsiveness of identified cell types using the activity marker agmatine (AGB). In the presence of an odor, externally applied AGB enters activated cells through non-selective cation channels. We exposed squid, *Lolliguncula brevis* to various odors plus AGB *in vivo*. The expression profiles of six amino acids were examined in fixed, embedded and sectioned (50 nm) olfactory organs. Serial sections stained for each amino acid were captured as 8-bit gray-scale images using 20X or 100X objectives. Following digital registration, cluster analysis was used to identify the cell types and quantify the amino acid contents. Images were analyzed for cell types and pixel area that had AGB labeling. Of 502 cells identified based on their metabolic profiles (10 preparations), 0.8% were type 1, 32% type 2, 26% type 3, 15% type 4 and 19% type 5. Odor-stimulated AGB labeling ranged from 0.8% in type 1 cells to 11% in type 3 cells. On average, odors stimulated AGB labeling of about 3% of the olfactory epithelium. Glutamate (50 μM) stimulation resulted in the largest percent area of AGB labeling. These data suggest that the 5 cell types differ in their relative abundance, odor responsiveness and metabolic profiles, as well as in their morphology.

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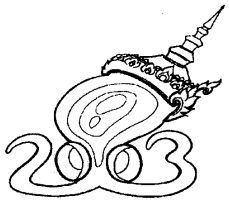


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# FIRST APPROACH TO THE QUANTIFICATION OF AGE PIGMENT LIPOFUSCIN IN BRAINS FROM *OCTOPUS VULGARIS* (MOLLUSCA: CEPHALOPODA)

The potential of the age-pigment lipofuscin as a physiologic age marker has been mainly assessed in crustacean species. In the present study the identification of lipofuscin was carried out on transversal sections of the optic gland (OG) from brains of wild-caught *O. vulgaris* under epifluorescence microscopy and quantified using image analysis techniques. Three different measurements of the lipofuscin level (granule mean size, % area fraction and granule density) were recorded in ten distinct OG sections of individual brains, these variables being analysed by individual, length class and sex. The concentration of lipofuscin, expressed as % area fraction and granule density, was independent of sex and increased significantly with length (weight). The mean size of granules was independent of length. A modal progression analysis of the lipofuscin frequency distribution showed three normal components. Results of this preliminary study confirm the potential of the lipofuscin method for resolution of cohorts in *O. vulgaris* and suggest that the application of this methodology can be useful in studies of age structure in wild populations.

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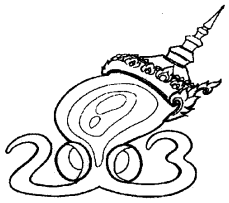


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# SQUID EMBRYO GROWTH AND SURVIVAL: THE ROLE OF MATERNAL CONDITION

By manipulating feeding regimes and environmental temperature of captive, female dumpling squid (*Euprymna tasmanica*) we explored the association of maternal condition with batch fecundity, egg size, embryonic development and hatching success. Since *E. tasmanica* is a multiple spawner it was also possible to track changes in these parameters over successive clutches. A two factor orthogonal experimental design, involving two feeding levels (high and low rations) and two temperatures (summer and winter), was implemented with half of the replicates used to explore embryonic development and the remaining half examining egg-yolk quality via fatty acid analysis. Animals maintained on higher rations laid larger egg clutches consisting of larger eggs, compared to those maintained on lower rations regardless of temperature. Both relative batch fecundity and egg size decreased over successive clutches in high fed squid. Relative batch fecundity also declined for low fed animals, however they managed to maintain egg size throughout the experiment. Embryonic mortality was consistently higher (>50%) in low fed squid and fatty acid analysis is currently being undertaken to examine the relative proportion of essential constituents and determine whether increased embryonic mortality was a function of poor yolk quality.

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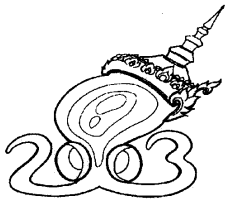

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# ARE BIGGER CALAMARY HATCHLINGS MORE LIKELY TO RECRUIT? A STUDY BASED ON STATOLITH DIMENSIONS

While growth rates and larval size are the principal determinants of recruitment success for marine fishes, it is not known if this holds true for squid which do not have a true larval phase. Positive relationships between *Sepioteuthis australis* hatchling (<8 hrs old) statolith dimensions and body size made it possible to retrospectively calculate an individuals' size at hatching from adult statoliths, exploring the 'bigger is better' hypothesis. The statolith radius (SR) displayed the strongest linear relationship to hatchling dorsal mantle length (ML) and was subsequently extrapolated from the hatch-check boundaries evident in prepared adult statoliths. Hatchlings were collected from October (2001) to February (2002) on natural spawning grounds located on the east coast of Tasmania using purpose built emergent traps. Hatchling size was extremely variable ranging from 4.3 to 7.3 mm (ML), with significantly larger animals hatching out in November and the smallest in February. Use of adults was confined to those that had been aged and back calculated to have hatched during these sampling months to avoid any seasonal effects. Preliminary results suggest that the distribution of extrapolated hatchling sizes from successfully recruited adults were skewed to the larger end of the hatchling spectrum.

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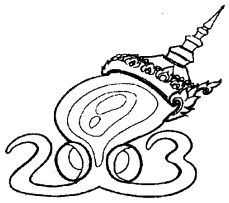


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# DIETARY EFFECTS ON FATTY ACID AND STABLE ISOTOPE PROFILES OF THE BRIEF SQUID *LOLLIGUNCULA BREVIS* – A FEEDING STUDY

Fatty acid and stable isotope analysis have previously been used to investigate foraging patterns of fish and marine mammals. To evaluate the application of these methods for dietary studies in squid, it is important to understand the degree to which fatty acid and stable isotope signatures of prey species are reflected in squid tissues.

Four groups of 15 squid each were fed, over 30 consecutive days, on live prey species using four different feeding regimes.

Group 1 was fed fish for 15 days then swapped to a crustacean diet ; group 2 received exclusively fish; group 3 received only crustaceans; group 4 was fed on a mixed diet of fish and crustaceans. Squid were sampled on day 10, 15 (group 1 only), 20 and 30. Fatty acid composition and stable isotope ratios were determined for squid digestive gland and muscle tissue and whole prey.

The fatty acid profiles of the squid tissues tended to reflect those of their prey. Squid that fed on a single prey type, *i.e.* fish or crustaceans, showed only minor changes in fatty acid proportions over the course of the experiment though fatty acid profiles were clearly distinguishable between the two groups. Shifts in fatty acid proportions towards respective prey profiles could clearly be observed in squid the diet of which was swapped after 15 days (group 1). Clear differences could also be seen in fatty acid profiles of squid feeding on a mixed diet (group 4) with trends towards either fish or crustacean fatty acid signatures.

Stable isotope signatures of squid tissues clearly distinguished between animals feeding on the different diets. This supports the findings of the fatty acid analysis. Thus, both methods are viable tools in feeding studies on squid species.

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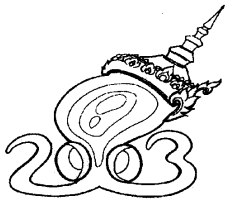


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# AGE AND MATURITY OF JAPANESE COMMON SQUID *TODARODES PACIFICUS* CAUGHT BY INSHORE FISHERIES OF THE SEA OF JAPAN

This study considered age and maturity of Japanese common squid *Todarodes pacificus* in inshore area of the Sea of Japan. The squid used for this study were collected by inshore fisheries of the Sea of Japan from April 1999 to March 2001. Age was estimated from 244 females, 197 males and 28 juveniles using statolith increment analysis. Matured females in the reproductive period were caught from April to August and from December to February. The age of these matured females were mainly less than 200 days. The females matured in less than 200 days were hatched throughout the year.

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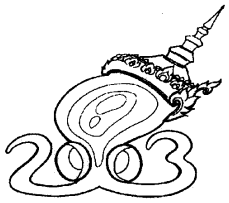


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# NUTRITION VALUE OF SQUID "AS FOOD FOR HUMAN ???"

The whole body, mantle, part of head and arm, liver and gonad of 10 species of squid from Thai waters were studied on nutrition value. All samples were minced and freeze dried prior to analysis. Protein, fat, ash, fiber and fatty acid profiles were examined. Analysis results showed that the protein content of all squid species is very similar, varying between 67.5 – 80.7% dry matters. While the content of fat, ash and fiber were between 2.22 – 8.48%, 4.48 –9.86% and 1.24-5.90%, respectively. Fatty acid profiles of all squid species showed the high content of n-3 HUFA, at the level above 30% of total fat.

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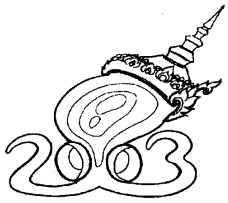


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# LIFE HISTORY TRAITS OF THE TEMPERATE MINI-MAXIMALIST *IDIOSEPIUS NOTOIDES*

Species from the *Idiosepius* genera are ideal biological models to study the unique life history traits of cephalopods, given their small size, ease of capture and short lifespan. This study describes the age, growth and maturation of the temperate 'mini-maximalist' *Idiosepius notoides* and compares these life history traits with those of its tropical congener *Idiosepius pygmaeus*. Age determination of *I. notoides* was carried out using statolith increment analysis. Growth was exponential in nature, with a maximum age of around 107 days. Males and females appeared to have similar lifespans, with females achieving a much greater size by growing faster. Although *I. notoides* grows to a larger size than its tropical counterpart, size at onset of sexual maturity was analogous between the two species, with males maturing at approximately 6.5 mm ML and females at 14 mm ML. Body size and age at maturity are key features in life histories, largely influencing an individual's fitness by determining the timing and amount of energy allocated to reproduction. *Idiosepius notoides*, like *I. pygmaeus*, is a multiple spawner and this research suggests that it may be depositing eggs over a very wide size range and large portion of the total lifespan.

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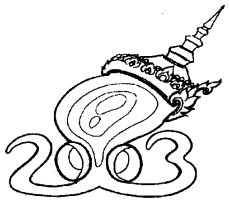


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# PLASTICITY IN SQUID GROWTH: IS IT GENETICS OR ENVIRONMENT?

The southern calamary, *Sepioteuthis australis*, of Australia and New Zealand has a complex population structure. It consists of 3 genetic types, the geographic distributions of which exhibit a markedly non-random pattern. One type is mainly found near the western and eastern limits of this species, while another is predominantly found in the intervening regions. Where these types overlap, a third hybrid-type is found. This hybrid is thought to be infertile. In an attempt to quantify the relative contribution genetic and environmental influences had on squid growth, 157 animals from 3 overlapping regions were aged by counting micro-increments in statoliths. Estimates of age ranged from 121 to 268 days and varied with mantle length, sex, genetic type and region. Significant differences were detected between genetic types, with the hybrids always growing faster (at least 60% larger at 150 days old) than the other 2 types. Some spatial differences in growth were also detected among types, but they were, on average, an order of magnitude less than those between types. These results, and the high incidence of cryptic speciation in squid, suggest that the extreme intraspecific plasticity commonly found in squid growth may be due to differences in genetics rather than the often-cited environment.

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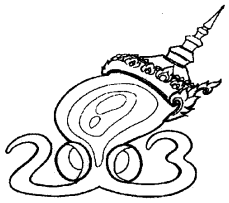


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# SPECIES COMPOSITION AND ECONOMIC IMPORTANCE OF CEPHALOPOD FISHERIES IN CAMBODIA

Recent surveys of marine biodiversity have identified 7 species of Cephalopoda in Cambodian waters. There are 2 species of squids, 2 species of cuttlefish and 3 species of octopus. All of these species are regularly found in the local fish markets and 4 of them are target species of commercial fisheries. Most are caught as by-catch in trap and trawl fisheries. Fisheries statistics at the present time are not very accurate. It is not possible to separate amounts of squid, cuttlefish and octopus. Total catch of cephalopods amounts to about 2-2,500 tonnes per year (1999-2001). This is less than 10% of the total marine fisheries. In Sihanoukville municipality the annual catch has increased 10-folds from 1992 to 2000. Cephalopods could yield an important contribution to animal protein in the diet of local people as well as a source of income for the fishermen. However, little or no information is available about the stocks and recruitment. We have collected eggs of at least one species, so reproduction does take place in Cambodian waters. In the present study we have identified the species available in local markets and fish landing sites, and we have interviewed fishermen and market vendors about the seasonal availability and value.

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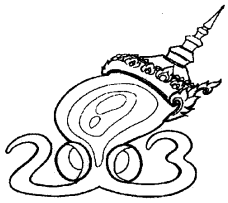


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# DISTRIBUTION OF THE EPIPELAGIC CEPHALOPODS IN THE WATERS ADJACENT TO OKINAWA ISLANDS, JAPAN

Distribution of the oceanic epipelagic cephalopods collected from the Okinawa Island, in the East China Sea was surveyed. Samples were collected from 47 stations with the surface trawl (30 x 30m mouth opening) in the depth of 0-30 m in night by the R/V Shunyo-Maru during 9 May to 19 June 1998. A total of 6,743 specimens were collected, and at least 31 species in 11 families of cephalopods were identified. Most abundant species was *Sthenoteuthis oualaniensis* (3,972 specimens), which occupied about 60% of total number, and following *Abralia similis* (934 specimens), *Abralia trigonura* (480 specimens). Most divergent family is Enoploteuthidae (12 spp.) which shares 40% of total number of occurred species. Distribution pattern of occurred species was computed using with several similarity indices, and analyzed with relation to the oceanographic condition. Distributions of four enoploteuthid species show the highly correspondence with the Kuroshio axis. Computed dendrogram was firstly bifurcated into the clusters "Mesopelagic boundary" and "Oceanic". "Oceanic" cluster was divided into "Pan-tropical" and "Indo-Pacific".

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# DIVERSITY OF POPULATION *SEPIA PHARAONIS* IN THE PERSIAN GULF AND GULF OF OMAN

The pharaoh cuttlefish (*Sepia pharaonis*) is the most dominant cephalopod species in the Persian Gulf and Gulf of Oman. The stock patterns of this species was studied from 1999 to 2000. In addition to measuring the biological patterns; 21 morphologic and meristic factors were measured or counted.
The results of LSD test showed that tentacle length ( TL ) , Tentacle club length (TCL) and TCL/ TL were indicative factors which they showed significant difference between male and female specimen of the Persian Gulf and Gulf of Oman regions.
Regarding to length and weight frequencies data, the results indicated that males are always bigger than females and also, the cuttlefishes of the Gulf of Oman are bigger than the Persian Gulf's samples. There was a significant correlation ( 95% ) between different quantitative parameters and the most correlation ( 0.963 ) was found to be between TL and TCL; whereas the less correlation ( 0.384 ) was observed between gill length ( GL ) and length of third arm ( LA3 ).
The results of cluster analysis for both sexes showed that the cuttlefishes of both studied regions belong to separate stocks.
Taking into consideration the findings of the present study including :
(1) difference in spawning season, (2) results of dendrograms, (3) observed significant differences in one-way analysis of variance (ANOVA) for morphometric measurements, (4) differences in body length and weight, (5) as well as ecological variations of the Persian Gulf and Gulf of Oman, have indicated that : the *Sepia pharaonis* of the Persian Gulf and Gulf of Oman waters can be belonged to two seperate stocks, but more studied such as genetic studies are needed to attest this result.

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# UNUSUAL INCIRRATE OCTOPODS FROM THE SOUTH SHETLAND ISLANDS, ANTARCTICA, INCLUDING *BATHYPURPURATA PROFUNDA*, A NEWLY DISCOVERED GENUS AND SPECIES OF DEEPWATER PYGMY OCTOPOD (CEPHALOPODA)

Among the many octopods collected during recent Antarctic trawling were several species that are not among the common Antarctic pareledonins. Three species are either poorly known or new to science, so we describe their morphology and anatomy. A very small (23 mm DML) mature female of a fragile, dark purple species without an ink sac has suckers in a single series and proportionally huge salivary glands. We consider it to be a new genus and species. A single *Graneledone antarctica* Voss is unusual because it is the largest reported specimen (104 mm dorsal mantle length, DML) and the first mature female. Six *Bentheledone* from a single deep (3213 m) sample and another, mature male caught nearby over five years later, may be *B. albida* (Berry), until now known only from the holotype. They are characterized by tiny anterior salivary glands, a small triangular calamus and small almost circular ligula.

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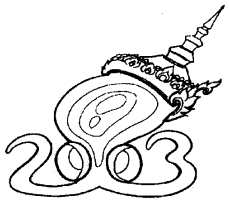


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# FEEDING AND DIGESTION IN SQUID PARALARVAE

Feeding and digestion was observed in live, laboratory-reared *Loligo opalescens* from 1 to 60 days after hatching (2.0–10.0 mm ML) under a compound microscope. Ingestion and digestion times (from capture to complete gut clearance) were obtained by image-analysis from video recordings. *L. opalescens* paralarvae can extend and contract their buccal mass and insert it inside the exoskeleton of crustacean prey during feeding, while flesh is ingested through radular movements. This leaves prey with intact empty exoskeletons and suggests early paralarvae perform external digestion when feeding on crustaceans. However, late paralarvae (>50 d) can ingest the hard parts of their prey. By comparing the gut appearance of actively feeding paralarvae with that of those held without food for several days, the condition between well nourished and starved animals could be recognized. The caecum, stomach, and midgut gland of starving paralarvae was contracted. Ingestion times decreased with increasing squid size. Digestion times ranged from 9 min for *Artemia* nauplii to 2 h for mysids at 17-18 ºC. The ecological significance of these findings to understand prey size preference and feeding rates of wild paralarvae is discussed.

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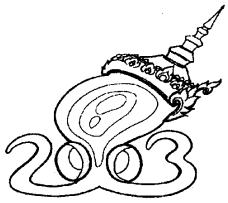


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# DEVELOPMENT OF PREDATORY BEHAVIOUR IN HATCHLING SQUID: THE ROLE OF ARMS AND TENTACLES

This study correlates behavioural observations with morphologic data to construct a detailed description of the role of the arms and tentacles of hatchling squid (*Loligo opalescens)* during prey capture. Newly-hatched squid exhibited only one predatory behaviour: Basic Attack (BA). During BA, arms and tentacles were spread apart before being thrust forward to make first contact with the prey. Tentacles were never extended and were morphologically similar to arms, with suckers along their entire length. Forty days after hatching, BA was replaced by Arm-Net (AN) and Tentacular Strike (TS) behaviours. During AN, tentacles were still functioning as arms and a forward jet propelled the hatchling towards the prey. In contrast, during TS no forward jet occurred and the hatchling remained stationary while tentacles were extended to make first contact with the prey.

In conclusion, hatchlings are not able to extend the tentacles and their prey capture behaviour is less successful than in adults. Ontogenetic changes in predatory behaviour of hatchling squids are closely related to morphologic changes in the arms and tentacles. These stereotyped predatory behaviours likely result from functional demands imposed by the developing mechanics of the tentacles. Implications of these findings for the survival of hatchlings are discussed.

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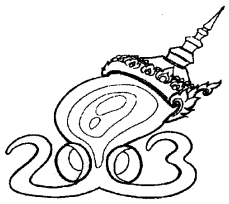

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# EMBRYONIC LIFE OF THE SQUID *LOLIGO VULGARIS* (CEPHALOPODA): A COMPARISON BETWEEN MEDITERRANEAN AND EASTERN ATLANTIC POPULATIONS USING STATOLITH ANALYSIS

We analyzed the possibilities of determining past events of squid early life from analysis of the embryonic area of statoliths of wild squid populations of *Loligo vulgaris*. First, the relationship between egg incubation temperature and daily growth of embryonic statolith under laboratory conditions was determined by tetracycline markings at different incubation temperatures, ranging from 12 to 24.7°C. Secondly, the mean width of embryonic increments in statolith collections of wild *L. vulgaris* from the Mediterranean Sea (Eastern and Central) and the Eastern Atlantic (NW Iberian Peninsula and Saharan Bank), was computed. Results indicate that, under laboratory conditions, embryonic statolith growth is linearly dependent on incubation temperature. Inferred temperature obtained from the embryonic increment widths of statoliths of wild squid indicates that embryonic development of *L. vulgaris* in the regions sampled is likely to occurs at temperatures ranging from 12 to 17°C. Squid seem to select a temperature range to spawn, avoiding high temperatures. Mediterranean squid have wider embryonic increments than Atlantic squid, this reflecting slightly higher water temperature in the Mediterranean Sea during the development of the egg masses. Results indicate that on average, egg masses of *L. vulgaris* spawned off the NW Iberian Peninsula (East Atlantic) remain at sea for 47d before hatching, *i.e.* 7d longer (or 18% more) than eggs spawned in the Mediterranean. These differences can be up to one month (or 83% more) when comparing minimum and maximum ranges. An increased hatching competence due to a larger hatching size is expected from squids incubated at lower temperature. On the other hand, a longer incubation time for egg masses attached to the sea bottom increases mortality risks. Therefore, a compromise between longer-versus-shorter incubation time and related characteristics does exist.

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# POST-HATCHING MORPHOLOGICAL CHANGES WITH GROWTH OF DIAMONDBACK SQUID *THYSANOTEUTHIS RHOMBUS*

*Thysanoteuthis rhombus* paralarvae ranging from 1.0 to 15.0 mm in mantle length (ML) are described based on specimens collected from western Australian waters. Paralarvae smaller than 3.0 mm ML are characterized by having a round mantle with a large number of chromatophores, long tentacles and small fins. Arms grow rapidly at 3.0-6.0 mm with the development of primordial protective membrane. At 15.0 mm ML, shape of the mantle is almost same as mantle of adult and fins reach to entire length of lateral mantle. Arm suckers are not prominent and naked on the distal one-third of the arms of specimens smaller than 8.0 mm ML. Development of protective membranes and relatively long arms in post-larval stage may be an adaptation to floating in the stream than active swimming and it suggests that *T. rhombus* has a long planktonic phase. The rostrum development of beaks and disappearance of lip cilia occurred at 6.0-8.0 mm ML, which may reflect the changes in their feeding habitat, and is possibly define the end of paralarval stage in the present species.

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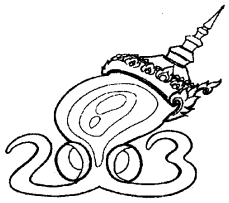


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# USING LIGHTS TO TRACK SQUID FISHING FLEETS FROM SPACE

This study examines the influence of environmental variability on the distribution of the fishing fleet targeting *Dosidicus gigas* (the jumbo flying squid) in the Southeast Pacific. As in the majority of ommastrephid species, *D. gigas* exhibits large fluctuations in abundance from year to year, which are thought to be related to environmental variability driven by the El Niño-Southern Oscillation (ENSO). The commercial fishery consists of a multinational jigging fleet, and the emission of light from squid jigging vessels can be observed using satellite-derived imagery obtained by the United States Air Force Defence Meteorological Satellite Program (DMSP) Operational Linescan System (OLS). Using a Geographic Information System (GIS), inter-annual variability in the location of the fleet (as derived from DMSP-OLS data) is compared with the local oceanography (using satellite derived sea surface temperature data) to examine the influence of El Niño and La Niña events on squid abundance and the distribution of fishery.

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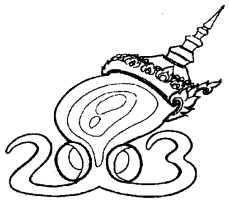


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# A HYPOTHESIS CONCERNING THE OCEANOGRAPHIC INFLUENCE ON CUTTLEFISH (*SEPIA OFFICINALIS*) MIGRATION AND ABUNDANCE IN THE ENGLISH CHANNEL AND ADJACENT WATERS

The oceanographic influence on cuttlefish migration and abundance in the English Channel and adjacent water are studied using both GIS and statistical methods. Oceanographic features, such as currents and sea fronts are detected using sea surface temperature derived from remotely sensed AVHRR data. CPUE (catch per unit effort), derived from fishery landings data for UK and French trawlers, is used as an abundance index. Currents and sea fronts have a clear influence on cuttlefish annual migration from the English Channel to deeper water at the west end of the English Channel and further west. Juveniles are always located in the frontal and warmer areas in the English Channel. The strength of the Atlantic currents into the west part of the English Channel and the south part of Celtic Sea may be the dominant influence on the time of cuttlefish migration to these areas from the English Channel. Following the westward retreat of cold Atlantic currents, adults migrate to the west end of the English Channel and further west into deeper water. It is also found that *Sepia* abundance is positively correlated to sea temperature during spawning and recruitment reasons in the English Channel.

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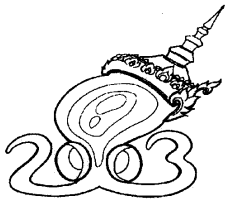


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# GENETIC DIVERGENCE AND GEOGRAPHIC DIVERSIFICATION IN *OCTOPUS* CF. *VULGARIS* BASED ON MITOCHONDRIAL DNA SEQUENCES

*Octopus* cf. *vulgaris* is one of the most thoroughly studied species among the commercially exploited cephalopods. Surprisingly, its distribution is not yet clarified. In particular, the distribution in the western Atlantic has recently been called in question. Therefore, we have investigated the genetic differences between various populations. Sequence variation in *O.* cf. *vulgaris* from eleven localities in the Mediterranean (France, Greece), the Atlantic Ocean (Lanzarote, Senegal, South Africa, Tristan da Cunha, southern Brazil and northern Brazil), the Caribbean Sea (Venezuela) and the Pacific Ocean (Taiwan and Costa Rica) was examined using the mitochondrial genes coding for the 16S rRNA and cytochrome oxidase III. Sequence divergences were studied, and trees were constructed by using maximum likelihood, neighbor joining and maximum parsimony algorithm (PAUP). The data suggest that *Octopus vulgaris* is present in both the eastern and western Atlantic.

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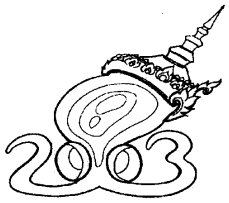


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# INTERPRETING CEPHALOPOD DISTRIBUTION USING PREDATORS FORAGING DATA

In marine systems, determining the distribution of some prey species, with important roles in those ecosystems can be attained. Cephalopods are a particular case, being hard to catch by conventional means such as scientific nets.
In recent years, predators have been used to sample cephalopods in the Antarctic Ocean. Albatrosses have particularly extensive foraging ranges, such as wandering albatrosses breeding in the South Atlantic, ranging from off Brazil (28°S) to Antarctic Peninsula shelf (63°S). Albatrosses also catch a wider range of cephalopods and sizes from scientific nets. Therefore we could learn as much about cephalopod ecology from these seabirds as we could from scientific nets.
We deployed satellite tracking devices on wandering albatrosses during their chick-rearing period at Bird Island, South Georgia (54°S 38°W) and collected food samples after each foraging trip. We also deployed an activity recorder on each bird to assess when, within the foraging trip, the bird was in contact with the water, keeping estimate where the bird may have been feeding. Finally, we used oceanographic data (sea surface temperature) to assess the time spent in each water mass (Antarctic, sub-Antarctic or subtropical waters).
Using these data we developed a simple procedure to estimate the distribution of cephalopods. This gave minimum and maximum estimates of probability of occurrence of each prey species in each water mass. These findings were compared with previous studies based on nets samples. The results suggest that analysing prey distribution using predators foraging data provides a useful additional way to study cephalopod distribution.

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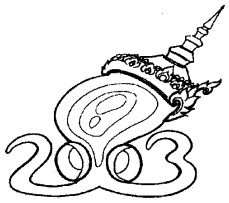


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# THE STUDIES OF THE ORGANIC MATRIX OF CUTTLEBONE: MOLECULAR WEIGHTS, CHARACTERISTIC INFRARED SPECTRUM AND AMINO ACID COMPOSITION

Organic matrix of the shell of *Sepia esculenta*, namely cuttlebone, was extracted by 10% acetic acid and double distilled water, and then analyzed with the technique of SDS-Polyacrylamide gel electrophoresis (SDS-PAGE), Fourier Transform Infrared spectrum (FT-IR) and amino acid composition. SDS-PAGE electrophoresis showed the number of bands of acid soluble matrix was less than that of aqueous soluble matrix, but protein concentration of the former was more than that of the latter. This may be attributed to two factors: the loss of the proteins of low molecular weight in the proceeding of dialyzing, and the poor resolution resulted from some very thick and broad bands. The FT-IR spectrum revealed amid, amine, and carboxylic acid groups in the organic matrix of the cuttlebone, with high sugar/protein ratio and strong sugar bands. Moreover, the $HCO_3^-$ groups could be at the organic mineral interface. The results of amino acid analyses indicated high contents of aspartic acid (Asp) and glutamic acid (Glu) in both the soluble and the insoluble organic matrix. The sum of them occupied close to 23% and 19%, respectively. Glycine (Gly) and Serine (Ser) were also present in a relatively high concentration. The total of Asp and Glu was obviously more than that of Ser and Gly in the soluble matrix, but to the contrary in insoluble matrix. Acidic amino acids could play important roles in the calcification of cuttlebone.

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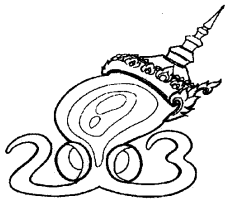


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# DOES PYCNOCLINE DEPTH AFFECT THE HATCHING SUCCESS OF *TODARODES PACIFICUS* PARALARVAE FROM PELAGIC EGG MASSES?

The egg masses of ommastrephid squids are thought to occur within the pycnocline, where developing embryos within the egg masses should be relatively safe from predation and mechanical damage that might occur at the surface. However, embryos could also be damaged if the mixing layer depth (MLD) extends to the sea bottom, which could cause the egg masses to come in contact with the bottom. The objective of the present study is to determine if the depth of the pycnocline relative to the sea bottom affects the hatching success of *Todarodes pacificus* paralarvae. Paralarvae were collected during four autumn surveys (1991-94) in the southwest Sea of Japan. The distribution of hatchlings (mantle length<1.0 mm) was used to infer areas where successful hatching occurred, and the MLD was defined as the depth of the pycnocline. Hatchlings occurred at 42-61% of the sampling stations in each survey. The MLD of the area where hatchings were collected was shallower than the bottom depth, but few were collected at stations where the MLD occurred at or near the bottom. These results suggest that successful hatching from egg masses is higher when the MLD is shallower than the bottom depth.

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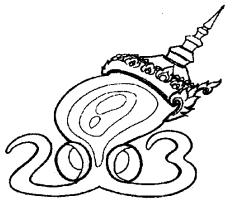


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# AGE DETERMINATION FROM GLADIUS LAMELLAE OF REARED BIGFIN REEF SQUID, *SEPIOTEUTHIS LESSONIANA* LESSON

Age determination from gladius lamellae has been studied on bigfin reef squid, *Sepioteuthis lessoniana* Lesson, reared in captivity from hatching to 60 days of age. The average number of lamellae of the squid hatchling (3.99 mm ML) was 4.9±0.9. The average numbers of lamellae were 8.9±1.0, 13.5±1.2 for the squids of 5 days (5.56 mm), 10 days (8.12 mm) of age after hatching, respectively. The average numbers of lamellae were 20.9±2.2, 26.6±1.5, 28.3±1.6, 57.3±6.0 and 70.1±5.8 for the squids of 15 days (12.57 mm), 20 days (16.39 mm), 25 days (16.65 mm), 50 days (50.49 mm) and 60 days (59.95 mm) after hatching, respectively. The relationships between age (A: days) and numbers of lamellae (NL) was $NL = 1.8\times10^{-3} + 0.977A + 4.578$ and between gladius length (GL: mm) and numbers of lamellae (NL) was $NL = 1.114GL + 5.399$. Average temperature was 29.96±0.97 ºC.

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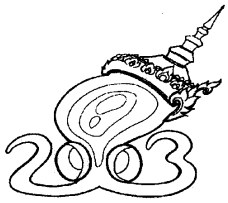


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# STATUS OF STUDIES ON CEPHALOPOD GENETIC DIVERSITY IN CHINA

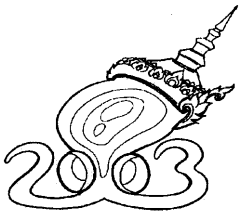
The study on genetic variation just began in China a few years ago in the following aspect:

1) Morphological variation: 4 samples of *Sepiella maindroni* collected from the coastal waters of China were researched with anatomical characters. Results indicated that the arm formula were different. The radulas of eight dibranchiate cephalopods were compared on the basis of scanning electron microscopic observation and morphological measurements. The differences were illustrated.

2) Chromosome variation: The karyotype of seven species of Cephalopoda using somatic cells (embryo) was firstly studied in 1990. The species that belonged to Teuthoidea and Sepioidea, respectively, were 92. The karyotype of *Octopus vulgaris* remarkably differed with *O. ocellatus*.

3) Protein variation: Allozymic electrophresis was used to investigate the genetic variation in 5 populations of *S. maindroni* in the East China Sea and South China Sea. The result revealed moderate levels of genetic variability. Nei's mean genetic distance ranged from 0.001 to 0.0018. Population structure of *O. variabilis* and *O. ocellatus* were also researched.

4) DNA variation: Sequence of cytochrome oxidase subunit I (COI) gene and 16S rRNA gene were also used to investigate the genetic variation in the 5 populations of *S. maindroni* mentioned above. No marked genetic difference was observed among those populations.



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# BIOACTIVITY IN SALIVA OF THE OCTOPUS *ELEDONE CIRRHOSA* (MOLLUSCA; CEPHALOPODA)

This study is the first on haemolytic and insecticidal activity in cephalopod saliva. Haemolytic activity against mammalian erythrocytes was detected in very low concentrations of saliva from the octopus *Eledone cirrhosa.* It was not caused by any previously identified compound of this saliva. The activity was slightly inhibited by trypsin and more drastically by chymotrypsin. A locust bioassay was used to test HPLC fractions isolated from *E. cirrhosa* and an $LD_{50}$ calculated for whole saliva injected into the desert locust *Schistocerca gregaria.* A third bioactivity was also studied. This was proteolytic activity and the enzyme was found to have chymotrypsin-like properties, revealed by its reactions with substrates and inhibitors. An interesting property of this chymotrypsin-like enzyme is its ability to be active at very low temperatures, which is not usual for chymotrypsin-like enzymes; the normal optimum temperature would be around 30°C.

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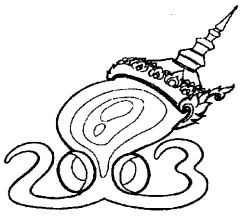

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# MALE REPRODUCTIVE SYSTEM OF THE GIANT SQUID, *ARCHITEUTHIS* SP.

The reproductive organs and spermatophores of three mature male giant squids (*Architeuthis* sp.) from South African waters are described. The functional parts of the reproductive system consist of a single testis, a vas deferens, a spermatophoric organ with an unusually long finishing gland, a very short, curved Needham's sac and a penis that is very long and protrudes well beyond the mantle cavity. Spermatophores were found in the penis of all three males. The spermatophores varied in total length from 55 mm to 204 mm and the total number present in Needham's sac and penis ranged from 32 to 140. The length of the cap, ejaculatory apparatus, cement body and sperm mass increased with total spermatophore length. Sperm implants were found in two males, two females and a head of unknown sex (probably female). Implants were found in the eye socket, mantle margin, on the head at the base of the 1st arm pair and more distally on the arms, and on the external surface of the penis. Sperm implants on the males may be accidental or possibly the result of capture and handling of the animal.

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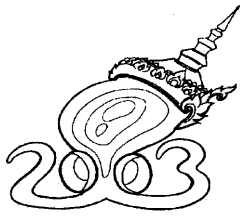

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# FATE OF THE COMMON SQUID POPULATION IN KOREAN WATERS; AN OCEANOGRAPHIC EXPERIMENT REPEATED ANNUALLY AND OVER A LONGER PERIOD

The catch of the common squid (*Todarodes pacificus*) in Korean waters exhibited a marked increase from the end of 1980s and continued since then. The area of the optimum temperature for squid spawning also widened during winter in southern waters of Korea, and no such trend is obvious during autumn. Warmer winters may have resulted in an extended spawning both in time and space, and hence contributed to a basis for more successful recruitment. With years of higher catch, the peak tended to shift to October from September. This indicates that more squids were hatched later in the season in those years. Consistently warmer winters observed in southern waters of Korea since the end of 1980s may signify a change on a large scale that accompanies an altered behavior of warm currents into Korean waters. This phenomenon is probably not limited to Korean waters or the squid, and may have taken place over a wider spatial scale and also with other components of the ecosystem. The fate of the squid population, however, could represent an oceanographic experiment repeated annually and over a longer period, because of its short life span and high yield at right conditions.

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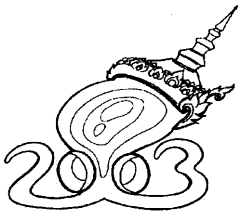

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## CEPHSCHOOL

CephSchool will be an online digital library designed to teach core concepts in life sciences. CephSchool will be supported by the data already existing in the CephBase relational database (www.cephbase.utmb.edu). This includes global scale coverage of all living cephalopods, 1,500 images, 144 videos, 5000 references, predator, prey and distribution data. The CephSchool site will devolve new content specifically for students and organized into eight arms (OCTOPUS!). These areas are: Online Laboratory Tour, Color Change in Cephalopods, Teachers Corner, Online Dissection Guide, Predators and Prey, Uses of Cephalopods, Students Corner and !links!. Cephalopods are ideal model organisms for teaching. Students are often drawn to them and they are colorful, active, interesting and different from vertebrates that are usually used. The site will facilitate access for students and teachers to the type and quality of information that is used by scientists

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**Publisher:**
Rayong Coastal Fisheries Research and Development Center
Coastal Fisheries Research and Development Bureau
Department of Fisheries
2003