Cephalopod International Advisory Council Symposium 2006 (CIAC '06)

6 – 10 FEBRUARY 2006

HOTEL GRAND CHANCELLOR, HOBART, TASMANIA

Program & Abstract Book

2006

Australian Government
Fisheries Research and Development Corporation

Tasmanian Aquaculture & Fisheries Institute
University of Tasmania

UTAS

Cephalopod International Advisory Council Symposium 2006

(CIAC '06)

Welcome

Welcome to CIAC '06, and to Tasmania, Australia. It is a privilege to host CIAC Symposia and we are pleased to be able to, with your help, deliver an exciting and diverse program covering a wide range of contemporary and topical scientific issues relevant to cephalopod biologists. Present at this Symposium are delegates representing 25 countries, presenting a total of 88 oral presentations and 87 posters.

There are a diversity of topics being presented at CIAC '06 and with only a single session, we provide you with the opportunity to experience and hear about areas of cephalopod biology and ecology that we may not be familiar with. So we hope that you enjoy hearing about topics that range from the hunt for giant squid and about interactions of cephalopods with predators, about what we are learning by tracking squid using cutting edge technology, how using numerical models enables us to understand squid population dynamics, and how cephalopod populations can be managed for the future.

There is always a sense of excited anticipation with CIAC meetings, the chance to catch up with old friends and colleagues and more importantly the opportunity to meet young scientists who are currently studying cephalopods. This is about tapping into the energy, enthusiasm, and passion that both new and established scientists have about cephalopod biology and ecology. All of us on the Organising Committee have been fortunate to experience the support and enthusiasm of cephalopod biologists at past CIAC meetings. We hope that during this week that we provide an environment that fosters encouragement and passion for everything about cephalopods by all of you.

We also are proud to be able to host the symposium in Tasmania; we hope that you enjoy your visit and you get a chance to experience the beauty of Tasmania.

The CIAC '06 Organising Committee

Natalie Moltschaniwskyj
Gretta Pecl
Jayson Semmens
George Jackson

Scientific Committee

Natalie Moltschaniwskyj
Gretta Pecl
Jaysen Semmens
George Jackson
Michael Steer
Malcolm Dunning

Hobart – the host city

Our island state offers all visitors a unique experience, with easy access to spectacular scenery, the world's tallest hardwood forests, rugged wilderness, vineyards and arts and crafts.

Hobart is a friendly city with a rich maritime history, It lies at the foot of beautiful Mount Wellington and its residents enjoy a comfortable lifestyle in a temperate climate, free of many of the pressures of larger cities. It is a city of fine restaurants, bustling market, fun festivals and entertainment. Hobart is an ideal base for your southern Tasmanian journeys – explore further afield, then return to relax, unwind and rejuvenate.

Hotel Grand Chancellor – the venue

Home of the Tasmanian Symphony Orchestra and located on the Hobart Waterfront, the hotel is a short walk from the city centre, Tasmanian Museum and Art Gallery, Maritime Museum, Salamanca Market, ferries and restaurants. The Hotel Grand Chancellor provides the ultimate in first class meeting facilities and accommodation with majestic views over the Derwent River, Mount Wellington and the city.

An ideal base from which to access Tasmania's tourist attractions, many of which can be visited on a half or full day tour, the venue offers all the comforts and facilities you would expect of a superior hotel. Disabled access is available in all areas of the Hotel Grand Chancellor Convention Centre. All major credit cards accepted.

Conference Secretariat

Conference Design Pty Ltd
PO Box 342
Sandy Bay TAS 7006
W: www.cdesign.com.au
E: info@cdesign.com.au
T: 03 6224 3773
F: 03 6224 3774

CONFERENCE DESIGN PTY. LTD
A.B.N. 72 050 482 507

General Information

Telephone Numbers

Registration Desk
P: (03) 6235 4508 Ext 4508

Hotel Grand Chancellor
1 Davey Street Hobart P: (03) 6235 4535

Dentist
Collins Dental Centre
158 Collins St Hobart P: (03) 6224 3575

Doctor
Dr Michael Welsh
102 Collins St Hobart P: (03) 6234 3600

Royal Hobart Hospital
48 Liverpool St Hobart P: (03) 6222 8308

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P: 131 008

Internet Cafes

Drifters Internet Cafe
Shop 9, 33 Salamaanca Pl Hobart
P: (03) 6224 6286

Harbour Lights Cafe
Hobart Waterfront Hobart
P: (03) 6224 2138

Messages

Messages will be attached to the Message Board located near the Registration Desk. Please check regularly.

Name Badges

A name badge will be supplied to delegates which enables them to attend all sessions. Daily catering will be available for full time delegates only in the Exhibition and Trade Area. Access to this area will only be available to those wearing their delegate or exhibitor name badge.

Speakers Room and Audiovisual

Speaker's preparation facilities are available in the Norfolk Room located on the Mezzanine Level. Please ensure your presentation is loaded at least 24 hours prior to presentation.

A technical assistant will be on hand in each of the presentation rooms. A computer and data projector will be provided as well as a laser pointer and lapel microphone.

Accommodation Accounts

All accommodation accounts must be settled on check-out. The Organising Committee and Conference Design will not be responsible for accommodation accounts.

Dress

Dress for the Welcome Reception will be jacket and tie; Wine and Cheese poster session will be neat casual (as for the Conference scientific sessions); and the Symposium Dinner will be 'After 5' wear.

Smoking Policy

The Conference has a "no smoking" policy. There are designated areas outside the hotel for smokers to use

Return Transfers to the Airport

We suggest you book a taxi or arrange with the concierge at your hotel to book a seat on the Airporter Shuttle Bus. The Hotel Grand Chancellor will make space available for luggage storage on Friday 10th February for those staying in the hotel as well as those staying at alternative hotels.

Special Requirements

Please advise the Registration Desk of any special requirements you have – eg, dietary, or mobility. If you have already advised Conference Design about a special diet the Conference venue will be aware of this. Please make yourself known to the waiting staff at all functions.

Privacy and Delegate List

A delegate list with name, organisation, position and state/country has been supplied to all Conference attendees including exhibitors and sponsors. Delegates who indicated "privacy required' on the Registration Form have not been included on the delegate list.

Conference Design Pty Ltd gathers and records personal information necessary for your attendance at the Conference. Personal information is gathered, stored and disseminated in accordance with the National Privacy Principles.

Disclaimer

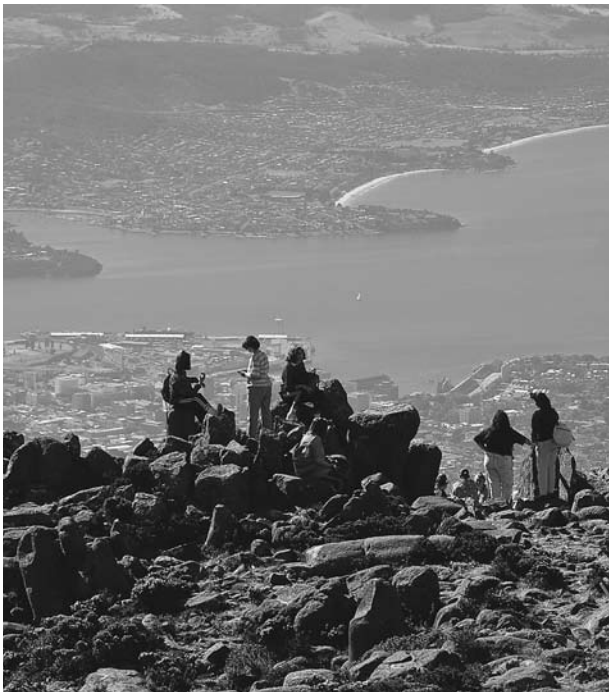
In the event of industrial disruptions or service provider failures, neither the Organising Committee members nor Conference Design Pty Ltd, accept responsibility for losses incurred by delegates and partners.

GST and Tax Invoices

A tax invoice was issued upon receipt of your Registration Form. All fees have been quoted in Australian Dollars (AUD) and are inclusive of the 10% compulsory goods and services tax (GST). If you have any queries please contact the Conference Registration Desk.

Sponsors and Exhibitors

The organising committee gratefully acknowledges the generous sponsorship and participation of the following companies:



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Exhibitors

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Blackwell Publishing

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Hallprint Pty Ltd is a small South Australian based family business which has manufactured innovative external fish tags to fisheries and aquaculture clients world-wide for nearly 25 years.

Hallprint is widely recognised by fisheries researchers for supreme quality external tag products, professional and friendly advice, competitive pricing and exceptional service standards. Hallprint was established in 1972 in Adelaide, South Australia, originally producing self-adhesive labels, and first became involved in fish tag manufacture in the early 1980s. Hallprint has specialised in producing external fish tags since 1984 and during this time many millions of fish, crustacean and molluscs including cephalopods have been tagged with Hallprint tags in over a hundred countries.

Global competitors have tried to emulate Hallprint's numerous technological and product innovations over the last two decades but have failed to bridge the gap.

Social Functions

Welcome Reception

6.00 – 7.00pm, Monday 6 February 2006

His Excellency, the Honourable Mr William Cox, AC, RFD, ED, Governor of Tasmania and Mrs Cox, have kindly offered to provide a Reception at Government House on Monday evening. Transport to and from the Hotel Grand Chancellor will be provided.

Only those who indicate (including partners) on the Registration Form that they wish to receive an invitation to Government House will be issued with an official invitation. Invitations will no longer be available to this function after 5 January 2006.

Dress: Jacket and tie

Cost: By invitation only

Wine and Cheese Poster Session

5.00pm – 7.00pm, Tuesday 7 February 2006

Sample some of Tasmania's wonderful wines and cheeses during this poster session. A great way to unwind at the end of the second day of conference sessions prior to the Wednesday free day.

Dress: Neat casual

Cost: Inclusive for Full Registrations

$40.00 for additional tickets

Official Symposium Dinner

7.00pm – Late, Friday 10 February 2006

The official Symposium Dinner will be held in the Grand Ballroom located at the Hotel Grand Chancellor Hobart. The dinner will highlight the best of Tasmanian fare and wine. A great opportunity to relax after the scientific sessions are complete and to farewell colleagues and friends.

Dress: After 5

Cost: Inclusive for Full Registrations

$95.00 for additional tickets

Activities and Tours

Sunday 5 February 2006

Wilderness and Wildlife Adventure – Bruny Island

Tasmanian wilderness at its best! Untouched wilderness and ocean coast wildlife. The spectacle of massive, stark cliffs shaped by the forces of nature. Spectacular views of Hobart, the Derwent River and Wrest Point Casino. Skirt the D'Entrecasteaux Channel noted for its aquaculture developments, pass through the tiny town of Snug and into the boating village of Kettering. Drive onto the Ferry for the crossing to Bruny Island. Enjoy a delicious complimentary morning tea on Bruny Island. Look for native wildlife along the Neck beside Isthmus Bay. Board our cruise boat at stunning Adventure Bay. Highlights of the tour include: The Monument, Nature's Cathedral – stark 300 metre high Jurassic dolerite cliffs; Breathing rock – the spectacle of an explosive blow hole; look for Sea Eagles' nests, pristine untouched rainforests and beaches, stunning sea caves and rock formations, Shearwater (Muttonbird) rookeries; explore Friar Rocks – home to over a thousand Australian Fur Seals and sea bird nesting areas, look for dolphins – they usually choose to be with us! Followed by a sensational seafood lunch in the beautiful surrounds of 'Hiba' – a 40 hectare property with panoramic water views.

Departs 7.50am from the Tasmanian Information Centre 20 Davey Street, Hobart

Adults $145.00 each Children $105.00 each

Wednesday 8 February

Mt Wellington and Peppermint Bay Cruise

Departs Hobart at 8.50am (outside the Hotel Grand Chancellor) for Mt Wellington via Salamanca and Battery Point. On return to Hobart the delegates will be taken to the Brooke St Pier for the Peppermint Bay Cruise which departs at 12noon. They cruise down the D'Entrecasteaux Channel to Woodbridge, viewing underwater life through the onboard cameras. A packed lunch is served on board the catamaran.

Following a tour of Woodbridge, return to Hobart at 5.15pm with a tour via the salmon farms and the Tasman Bridge.

Adults $110.00 each. Children $62.50 each

Wednesday 8 February

Dive at Eaglehawk on the Tasman Peninsula

For scuba diving, the Tasman Peninsula is the perfect venue for a day's diving. The area offers fabulous above-water scenery with massive cliff formations towering up to 277 metres above sea level. These walls continue underwater and combined with the rich invertebrate life provide spectacular diving. In addition, whales and dolphins are regularly sighted on this part of Tasmania's coast. Two dives (includes all dive gear, wetsuits and weightbelts and tea/coffee). The tour includes transfers (departing from the Hotel Grand Chancellor at 7.30am returning at 5.30pm) and lunch.

Limited to 7 people.

Adults $240.00 each.

ACCOMMODATION

1. Hotel Grand Chancellor
2. Fountainside Motor Inn
3. Montgomery's Private Hotel
4. Somerset on the Pier
5. The Old Woolstore
6. Hollydene

Cephalopod International Advisory Council Symposium 2006

(CIAC '06)

WORKSHOPS

Workshop 1

Movement and Migration of Cephalopods (Hobart)

Hobart 9.00am – 5.00pm, 2 – 3 February
Cost $100.00 (2 day workshop)

Modern technology has opened up many fields of research that allow us to follow the movements of mobile marine animals in ways not possible a short time ago. Most cephalopods live for a relatively short period of time, leading to a high rate of turnover and resulting in populations that are highly dynamic and extremely variable in terms of both recruitment levels and individual characteristics. We need tools to identify regions or environments that individuals have been utilising to grow, feed and spawn in order to explore where and how such variability arises. From a population level such information may assist us in understanding the spatial and temporal links between populations, including gaining insights into stock structure and the determination of source and sink areas for commercially fished populations.

New technology together with novel takes on existing techniques are allowing us to unravel the complex movements, behaviours, and patterns of habitat usage of cephalopods, over a range of spatial and temporal scales.

The techniques currently being utilised are as varied as cephalopods themselves – ranging from tagging (including satellite tracking, remote and real time acoustic monitoring), microchemistry and trace element analysis of hard parts, genetic techniques, analysis of parasites and heavy metals, through to the tracking of fishing fleets to follow migrations.

A two-day workshop is planned specifically for researchers with interests in the above techniques, questions and approaches. We would like to tailor the workshop to suit the questions and interests of the participants involved – there are many different aspects that could be covered ranging from the inclusion of very hands-on sessions (eg applying tags and actively tracking squids and octopuses, or laser ablation for determination of trace elements) through to seminars from researchers using these techniques and open discussion sessions. One expectation we have is the production of a many-authored review paper clarifying suitable applications for the major techniques, consideration of appropriate spatial and temporal scales for each approach, and an examination of how multiple methods may be used in tandem for more comprehensive resolution of research questions.

Jayson Semmens (Jayson.Semmens@utas.edu.au)
Gretta Pecl (Gretta.Pecl@utas.edu.au)

Workshop 2

Southern Ocean Cephalopods (Hobart)

Hobart 9.00am – 5.00pm, 2 – 3 February
Cost $100.00 (2 day workshop)

Cephalopods are pre-eminently important within the Southern Ocean ecosystem. However, this is a region where there is urgent need for more research into their biology, systematics and ecology. This workshop will provide a forum for experts from around the world to participate in establishing what we know and what are particular research needs. Some of the important issues that will be discussed will be:

- Life history and ecology
- Groups needing systematic work and means of updating taxonomy
- Incorporation of Southern Ocean cephalopods into the barcode of life program
- New techniques/technologies for looking at predator-prey interactions
- The role of cephalopods on the Southern Ocean food web
- Advances in beak identification
- Recommendations for future research.

George Jackson (george.Jackson@utas.edu.au)

Workshop 3

Cephalopods as Experimental Animals (Launceston)

Launceston 9.00am – 5.00pm, 2 – 3 February
Cost $100.00 (2 day workshop)

Increasingly researchers are using laboratory-based experiments to explore aspects of the biology and ecology of cephalopods for fisheries and aquaculture-related questions.

The aim of this workshop is to explore the use of laboratory based experiments in understanding cephalopods and there are several issues worth pursuing in this context:

- How growth experiments in the lab can be extrapolated to wild populations
- Using lab experiments to understand early life history of wild populations
- Aquaculture potential of cephalopods
- Ethical issues using cephalopods in experiments
- Design of aquaria, non-recirculating and recirculating systems to hold cephalopods.

Depending on the numbers attending, there will either be a series of smaller workshops addressing each of these issues, or a single workshop addressing some of these issues.

Organiser: Natalie Moltschaniwskyj
Natalie.Moltschaniwskyj@utas.edu.au

Cephalopod International Advisory Council Symposium 2006

(CIAC '06)

PROGRAM

MONDAY 6 FEBRUARY 2006

ECOSYSTEMS; THE ROLE OF CEPHALOPODS

Chair: Mike Vecchione

0830 **Welcome**
Opening Address: The Governor of Tasmania, His Excellency, the Honorable Mr William Cox, AC RFD ED
Welcome Address: The President of CIAC, Dr Michael Vecchione

0915 Stable isotopes, beaks and predators: a new tool to study the trophic ecology of cephalopods
Yves Cherel*, Keith A Hobson

0945 Nektonic squid as biological pumps between oceanic ecosystems
Alexander Arkhipkin

1000 MORNING TEA

Chair: Mike Vecchione

1045 Prey size-predator size relationships of squid and their predators in the Northwest Atlantic
Michelle Staudinger*, Francis Juanes

1100 Using DNA to explore cephalopod diet
Kevin Redd*, Jayson Semmens, Gretta Pecl, Stewart Frusher

1115 Effect of the environment on age structure and recruitment of the Argentine shortfin squid, *Illex argentinus*, in the Southwest Atlantic
Lianos Triantafillos*, Alexander Arkhipkin, Zhanna Shcherbich

1130 Octopod community and distribution patterns around Elephant Island, Antarctica
Uwe Piatkowski*, Louise Allcock, Michael Vecchione

1145 Did Antarctic octopuses colonise the deep sea?
Jan Strugnell*, Louise Allcock

1200 LUNCH

Chair: Alexander Arkhipkin

1300 Pelagic cephalopods from oceanic waters off Eastern Australia: species composition and distribution determined from the diets of large pelagic fishes
Jock Young, Matt Lansdell*

1315 Cephalopod prey fields in relation to sperm, pilot, and beaked whale sightings off Bear Seamount and Georges Bank in 2002.
Mollie Oremland, Michael Vecchione*, Gordon Waring, Elizabeth Shea, Ruth Gibbons

1330 Feeding habits of the blue shark (*Prionace glauca*) and salmon shark (*Lamna ditropis*) in the transition region of the western North Pacific
Tsunemi Kubodera*, Hikaru Watanabe, Taro Ichii

1345 Predator-prey interactions in the Southern Ocean: Identification of growth and post-spawning periods of Antarctic squids using albatross diets
Jose Xavier*, John Croxall

1400 The diet of sperm whales, *Physeter macrocephalus*, stranded in New Zealand: Implications for conservation
Felipe Gomez-Villota

1415 The diet of pygmy sperm whales, *Kogia breviceps,* stranded in New Zealand: Implications for conservation
Emma Beatson

1430 AFTERNOON TEA

MOVEMENT & MIGRATION

Chair: Ron O'Dor

1500 Estimation of target strength and mantle length, and behaviour observation of squids using in situ acoustic-optical system
Kouichi Sawada*, Hideyuki Takahashi, Koki Abe, Taro Ichii, Hiroki Yasuma, Kazutoshi Watanabe, Yoshimi Takao

1515 Why won't my octopus come back: utilizing passive telemetry to understand the dynamics of an octopus population
Jayson Semmens*, Julian Harrington

1530 Determining natal origins of hatchling squids based on trace element fingerprints within statoliths
Gretta Pecl*, Sean Tracey, Leonid Danyushevsky

1545 Microchemistry analysis of statoliths from neon flying squid (*Ommastrephes bartramii*) in the North Pacific
Chia-Hui Wang*, Chih-Shin Chen, Wann-Nian Tzeng, Cheng-Feng You, Tai-Sheng Chiu

1600 Determining connectivity of cephalopod populations using statolith chemistry
Bronwyn Gillanders*, Melita de Vries, Steve Donnellan

1615 Spatial patterns in key biological features of the chokka squid, *Loligo vulgaris reynaudii* on the Agulhas Bank, South Africa
Leonard Olyott*, Warwick Sauer, Tony Booth

1630 Egg balloon masses discovered in the Agulhas Current (South Africa) challenge current wisdom and suggest the possibility of an ommastrephid squid fishery in the region
Michael Roberts*, Perick Penvin, Allan Connell

1730 Group photo

1745 **Government House Reception**

1900 **Close**

SYSTEMATICS, BIOGEOGRAPHY & BIODIVERSITY

Chair: Michele Nishiguchi

0830 First-ever observations of a live giant squid in the wild
Tsunemi Kubodera* and Kyoichi Mori

0900 Conservation of Hox genes among molluscs: the cephalopod exception
Laure Bonnaud*, Jean S Deutsch, Mathieu Pernice, Renata Boucher-Rodoni, Aude Andouche

0915 Issues in Oegopsid phylogenetics: can molecular data help to further resolve relationships within Oegopsida?
Annie Lindgren

0930 Phylogeny and population genetics of *Alloteuthis* (Loliginidae) and discovery of a cryptic species
Frank Anderson*, Vladimir Laptikhovsky, Adria Pilsits, G. Bello

0945 Genetic diversity of isolated populations of *Nautilus pompilius* in the Coral Sea
Billy Sinclair

1000 MORNING TEA

Chair: Jan Strugnell

1030 Genetic and morphological identification of *Onykia* paralarvae from Northern Hawaiian and western Pacific Waters
Toshie Wakabayashi*, Tsunemi Kubodera, Taro Ichii, Mitsuo Sakai, Seinen Chow

1045 Squids of the family Gonatidae – genetic relationships and life cycle strategies
Oleg Katugin*, Annie Lindgren, Esmeralda Amezquita, Michele Nishiguchi

1100 Species complex of *Octopus minor* (Cephalopoda: Octopodidae) from Taiwan waters, including two new species
Chuan-Wen Ho*, Chen-Cheng Cheng, Chung-Cheng Lu

1115 Deep-sea pelagic cephalopods of Bear Seamount
Elizabeth Shea*, Michael Vecchione

1130 Population dynamics of a sepiolid squid-*Vibrio* mutualism from the Indo-west Pacific
Michele Nishiguchi*, Bryan Jones

1145 Resolutions and origins of the octopods
Mark Norman

1200 LUNCH

Chair: Tsunemi Kubodera

1300 Demersal cephalopod assemblages and diversity off the northeastern coast of Greece (NE Mediterranean)
Eugenia Lefkaditou*, Nina Fragopoulou, Costas Papaconstantinou

1315 Description of paralarval *Architeuthis* and Onychoteuthidae squid (Cephalopoda: Teuthoidea) From New Zealand waters
Steve O'Shea*, Chung Cheng Lu, Malcolm Clarke

1330 Review of the systematics, diversity, and spatial and temporal distribution of the New Zealand onychoteuthid fauna
Kathrin Bolstad

1345 Taxonomic review of *Argonauta cornuta*, Conrad, 1854 (Cephalopoda)
Andres Gonzalez

1400 Isolation and phylogenetic analysis of bacteria with antimicrobial activities from excretory organs of Nautilus
Mathieu Pernice

1415 Hearing in octopus
Kenzo Kaifu *, Susumu Segawa, Koitiro Tuchiya

1430 Spatial distribution pattern of sympatric tropical octopuses in the coastal waters of the Ryukyu Islands
Natsumi Kaneko*, Prof Yuzuru Ikeda

1445 Antarctic cephalopods – biodiversity and the census of Antarctic marine life
Victoria Wadley* and Michael Stoddart

1500 AFTERNOON TEA

REPRODUCTIVE BIOLOGY

Chair: Warwick Sauer

1530 Sex change or intersexuality? Nidamental glands in males of the oceanic squid *Ancistrocheirus lesueurii*
Henk-Jan Hoving*, Marek Lipinski, Martina Adriana Compagno Roeleveld, J.J. Videler

1545 Life history of *Loligo vulgaris* on the shelf of the Thracian Sea (NE Mediterranean)
Eugenia Lefkaditou*, Panagiotis Kaspiris

1600 Spermatophore formation in Loliginidae: morphology, histology and histochemistry of the spermatophoric organ of *Loligo plei*, *L. sanpaulensis* and *Lolliguncula brevis*
José Eduardo A.R. Marian*, Osmar Domaneschi

1615 Dimorphism in sperm investment patterns associated with alternative mating tactics in the squid *Loligo bleekeri*
Yoko Iwata*, Yasunori Sakurai

1700 Wine and Cheese Poster Session, Mezzanine Floor, Hotel Grand Chancellor

1900 Close

CEPHALOPODS & THE ENVIRONMENT

Chair: Yasunori Sakurai

0830 Estimating the growth of deep sea squid through an individual-based model approach: without and with energetics constraints
Eric Grist*, George Jackson, Elizabeth Fulton

0900 Effect of silver on maturation and development of the eggs of cuttlefish, *Sepia officinalis*
Thomas Lacoue-Labarthe*, Paco Bustamante, Estelle Le Bihan, Noussithé Koueta

0915 Localisation and characterization of digestive enzymes in cuttlefish, *Sepia officinalis*
Simeoni Noussithe Koueta*, Armelle Perrin, Mlle Estelle Le Bihan

0930 Overview of metal physiology in cephalopods: general implications
Paco Bustamante

0945 Statolith and gladius aging of the southern arrow squid (*Nototodarus sloanii*)
Jean McKinnon*, George Jackson

1000 MORNING TEA

Chair: Jayson Semmens

1045 Life cycle characteristics of the neon flying squid associated with oceanographic regime in the north Pacific
Taro Ichii*, Kedarnath Mahapatra, Mitsuo Sakai, Denzo Inagake

1100 Modelling intra-annual abundance variation of *Illex argentinus* in the southwest Atlantic using generalised additive models
Dr Chih-Shin Chen*, Tai-Sheng Chiu

1115 Environmental influences on the recruitment of *Illex Argentinus* in the southwest Atlantic: I. The impact of onshore current on larval dispersal
Cheng-Hua Chang*, Geoff Kirkwood, Murdoch McAllister, Lynne Purchase, John Beddington

1130 Environmental influences on the spatio-temporal distribution and abundance of the Southern Australian arrow squid, *Notodarus gouldii*
Kate Stark

1145 How environmental factors affect the stock size of ommastrephid squids – a possible scenario
Yasunori Sakurai*, Sachi Miyanaga, Jun Yamamoto, Ken Mori

1200 The giant Pacific octopus (*Enteroctopus dofleini*) in Prince William Sound, Alaska – adaptive foraging, population trends, and climate change
David Scheel*, Tania Vincent

1230 LUNCH

EARLY LIFE HISTORY

Chair: Mike Steer

1330 Distribution and growth of the common squid paralarvae in the Ria of Vigo (NW Spain)
Angel F. González*, Jaime Otero, Angel Guerra

1345 Relationship between RNA/DNA ratio and growth in reared squid paralarvae during starvation and refeeding
Erica Vidal

1400 The role of initial hatchling size and temperature on the growth captive pale octopus *(Octopus pallidus)*
Stephen Leporati*, Gretta Pecl, Jayson Semmens

1415 Comparative study of the embryonic development of the Japanese ocellate octopus *Octopus ocellatus* (Gray, 1849) and *Octopus vulgaris*
Hidehiko Hashimoto*, Kotaro Tsuchiya, Susumu Segawa

1430 AFTERNOON TEA

Chair: Mike Steer

1500 Optimising a closed system for culturing New Zealand broad squid, *Sepioteuthis australis*
Jason Tutara

1515 Temporal changes in the inferred areas of optimal survival of Japanese common squid (*Todarodes pacificus*) paralarvae caused by winter cooling on the spawning grounds
Jun Yamamoto*, Yasunori Sakurai

1530 Postembryonic development of the adhesive organ in *Idiosepius* under artificial conditions
Takashi Kasugai, Shuishi Shigeno, Waltraud Klepal, Janek Von Byern*

1545 Upper-beak growth increments in ommastrephid paralarvae
Mitsuo Sakai, Norma E. Brunetti, John Bower, Beatriz Elena, Tsuneo Goto, Taro Ichii, Marcela Ivanovic, Yasunori Sakurai, Toshie Wakabayashi and Akihito Yatsu

1600 Reports from workshops

1700 Close

MANAGEMENT & CONSERVATION

Chair: George Jackson

0830 New method of direct stock assessment of the loliginid squid
Marek Lipinski*, Mike Soule

0900 A Bayesian Delury model for the stock assessment of *Loligo gahi* from Falkland Islands waters
Pia Orr

0915 A multi-indicator system for the assessment and management of the short-fin squid *Illex coindetii* (Verany 1839) stock in the southern Adriatic Sea (Central Mediterranean)
Luca Ceriola*, Nicola Ungaro, Francesco Toteda

0930 The English Channel stock of *Sepia officinalis*: Can biomass dynamic models snd survey indices help to understand the increase in landings?
Beatriz Roel, Georg Engelhard, Juliette Royer, Véronique Legrand, Franck Coppin, Jean-Paul Robin*

0945 Population structure in the giant Australian cuttlefish: Combining information from molecular, morphometric and chemical approaches
Melita De Vries*, Bronwyn Gillanders, Steve Donnellan, Leanne Wheaton

1000 MORNING TEA

Chair: Roger Villanuera

1045 The diversity of cephalopods in commercial fisheries of New South Wales, Australia
Jonathan Nottage*, Steven S. Montgomery, Ron J. West, Ken J. Graham

1100 Fisheries biology of northern Australian squid
Malcolm Dunning*, Leonard Olyott, Kate Yeomans

1115 Management of the Southern Squid Jig Fishery
Philip Domaschenz*, Yvonne Zunic*

1130 Assessing the feasibility of using 'by-catch' data as a pre-recruit index in South Australia's southern calamary (*Sepioteuthis australis*) fishery
Mike Steer

1145 Co-operative development of area-based management of southern calamary
Matt Bradshaw

1200 LUNCH

Chair: Marek Lipinski

1300 An ecological study of nautilus at Osprey Reef
Andrew Dunstan

1315 Key behavioral attributes of squid and cuttlefish spawning aggregations that warrant consideration for conservation and fisheries management
Roger Hanlon

1330 Assessing the validity of stylets as ageing tools in *Octopus pallidus*
Zoe Doubleday*, Jayson Semmens, Gretta Pecl, George Jackson

1345 Management of Tasmanian octopus fisheries
Rod Pearn

1400 Southern calamary: an overview of reproductive biology relevant to fisheries management
Natalie A. Moltschaniwskyj, Gretta Pecl, Ty Hibberd

1415 AFTERNOON TEA

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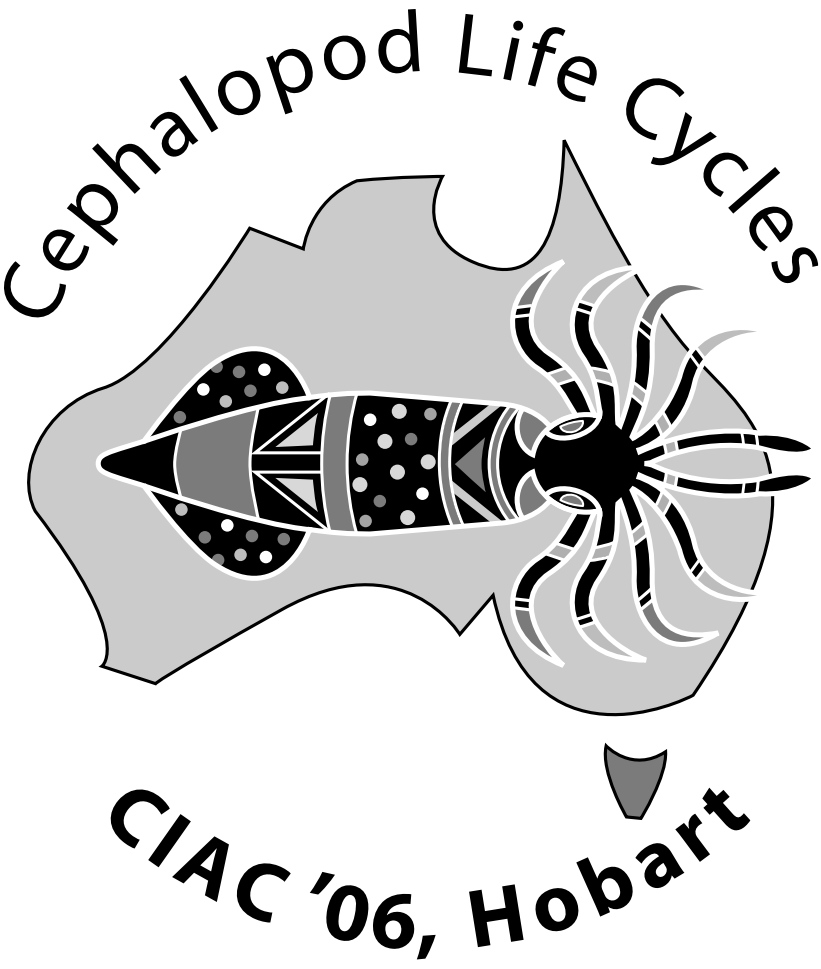


Oral Abstracts

2006

ORAL ABSTRACTS INDEX

Stable isotopes, beaks and predators: a new tool to study the trophic ecology of cephalopods

Yves Cherel[1], Keith A. Hobson[2]

[1]Centre d'Etudes Biologiques de Chizé, UPR 1934 du CNRS, BP 14, 79360 Villiers-en-Bois, France
email: cherel@cebc.cnrs.fr

[2]Prairie and Northern Wildlife Research Centre, Environment Canada, Saskatchewan S7N 0X4, Canada

We developed a new tool to investigate the feeding ecology of cephalopods by combining the use of their predators as biological samplers together with measurements of the isotopic signature of their beaks. Beaks are chitinous hard structures that resist digestion, and the stable isotope ratios of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) are indicators of the foraging areas and trophic levels of consumers, respectively. In agreement with a dietary shift from lower to higher trophic levels during growth, beaks from the same species show a progressive increase in their $\delta^{15}N$ values with increasing size, and there is an increase in the $\delta^{15}N$ signature of various parts of the same lower beaks reflecting their progressive growth. We also investigated the trophic structure of a cephalopod community living in subantarctic waters. Values of $\delta^{15}N$ indicate that cephalopods encompass almost three distinct trophic levels with a continuum of two levels between crustacean- and fish-eaters, and a distinct higher level occupied by *Mesonychoteuthis hamiltoni*. $\delta^{13}C$ values demonstrated that cephalopods grew in three different ecosystems, with most species living and developing in Kerguelen waters and two species migrating from either Antarctica or the subtropics. The stable isotopic signature of beaks accumulated in predators' stomachs appears thus to be a powerful tool to investigate the role of cephalopods in their marine environment.

Nektonic squid as biological pumps between oceanic ecosystems

Alexander Arkhipkin

Falkland Islands Government Fisheries Department,
PO Box 598, FIPASS, Stanley, FIQQ 1ZZ, Falkland Islands, aarkhipkin@fisheries.gov.fk

The unique life history traits of several abundant nektonic ommastrephid squid, such as *Illex argentinus, I. illecebrosus, Todarodes sagittatus* and *Dosidicus gigas*, suggest that they may function as fast-acting biological 'pumps' between oceanic ecosystems. These traits include:

- The vast species range consisting of spawning (SG) and feeding grounds (FG) located in different ecosystems hundreds and even thousand miles apart;
- Semelparity, which results in squid migrations from SG to FG and back to SG only once during their short (annual) life cycle;
- The arrival to FG on the continental shelf in large numbers due to low levels of predation encountered early on in life in the SG epipelagic waters;
- Relatively low mortality on FG, because squid appear there at size (>18-20 cm) inaccessible to the majority of shelf fish and seabirds;
- High food conversion rates coupled with a voracious appetite meaning that squid could double in size and increase their weight almost tenfold whilst on FG. Subsequently they convert a significant part of the biological production of the shelf into their body mass;
- One-way transfer of this production from FG to SG ecosystems in a short (several months) period of time.

Prey size-predator size relationships of squid and their predators in the Northwest Atlantic

M.D. Staudinger, F. Juanes
University of Massachusetts Amherst, Department of Natural Resources Conservation,
Amherst, MA, 01003-9285, email: mstaudin@nre.umass.edu

In the Northwest Atlantic, two species of squid, *Illex illecebrosus* and *Loligo pealeii* have been identified in food habits studies as a principal prey resource to numerous commercially and ecologically valuable predators including a diversity of finfish, elasmobranchs, and marine mammals. In spite of this importance, a basic understanding of the mechanisms controlling predation risk and predatory demand on squid populations is lacking. The relationship between predator and prey body size has been cited as the most important factor constraining predation; however, little information exists on the size-dependent relationships between squid and their predators. Using predator and prey length data collected as part of the National Marine Fisheries Service long-term ecosystem monitoring program, the Apex Predator program, and the Coastal Oceans program, we combine least squares and quantile regression techniques to analyze scatter plots and determine body-size relationships between squid and their predators. Correlation analysis is used to evaluate trophic niche breadths and variability in utilization of squid as a prey resource. The results of this study quantify the size ranges of squid most vulnerable to predation, document how predation on squid varies ontogenetically among predators, and gives insight into how changes in community structure may impact squid populations in the Northwest Atlantic.

Using DNA to explore cephalopod diet

Kevin Redd, Jayson Semmens, Gretta Pecl, Stewart Frusher
Marine Research Laboratories, Tasmanian Aquaculture and Fisheries Institute, University of Tasmania
email: ksredd@postoffice.utas.edu.au

The goal of the project was to determine the possibility of using molecular prey detection techniques to examine the range of prey consumed by local cephalopods, *Octopus pallidus* and *Sepioteuthis australis*. Newly emerging techniques in molecular biology were used to identify prey species by their unique DNA signatures. These DNA-based techniques have proven to be very effective in cases where conventional gut content analysis by dissection is not practical or informative. Here we describe extraction of total DNA from the contents of cephalopod digestive tracts and the use of universal 16s PCR primers to amplify total prey DNA from the stomach and caecum of *Octopus pallidus* and *Sepioteuthis australis.* The amplified DNA was then inserted into a plasmid vector to construct a clone library of cephalopod prey. The resulting plasmids were sequenced and the sequences compared to those in the National Center for Biotechnology Information nucleotide database by BLAST searching.

Effect of the environment on age structure and recruitment of the Argentine shortfin squid, *Illex argentinus*, in the Southwest Atlantic.

Lianos Triantafillos, Alexander Arkhipkin, Zhanna Shcherbich

Falkland Islands Fisheries Department, PO Box 598, FIPASS, Stanley, Falkland Islands. Tel: 500 27260; Fax: 500 27265; ltriantafillos@fisheries.gov.fk

The Argentine shortfin squid*, Illex argentinus,* is one of the world's largest squid fishery resources. Since 1999, the commercial catch of this species in Falkland Islands waters alone has plummeted from 266,000 tons to less than 1800 tons in 2004. This marked decrease is thought to be a combination of non-regulated overfishing on the High Seas and poor recruitment due to a shift in oceanographic conditions in the Southwest Atlantic. To test the latter, the age of about 2000 individuals, collected on the continental shelf near 46° S, 61° W in February and March for the years 1999 to 2005 inclusive, were determined and compared with oceanographic variables such as the strength of the Falklands Current and sea surface temperatures. Estimates of squid age caught in these two months ranged from 121 to 300 days and age structures varied considerably between years. In warm years, when catches were poorest, squid were generally younger and had faster growth and maturation rates than those caught in cold years. Possible explanations for these shifts in age structures and their implications to the management of this resource are discussed.

Octopod community and distribution patterns around Elephant Island, Antarctica

Uwe Piatkowski[1], A. Louise Allcock[2], Michael Vecchione[3]

[1]Leibniz-Institut für Meereswissenschaften (IFM-GEOMAR), Düsternbrooker Weg 20, 24105 Kiel, Germany, www.ifm-geomar.de, upiatkowski@ifm-geomar.de

[2]Marine Systems Research Group, School of Biology and Biochemistry, Queen's University Belfast, 97 Lisburn Road, Belfast BT9 7BL, UK, l.allcock@qub.ac.uk

[3]National Marine Fisheries Service, Systematics Laboratory, National Museum of Natural History, Washington, D.C. 20560, USA, vecchiom@si.edu

A comprehensive study of octopods around Elephant Island and nearby sites was conducted during two recent research cruises of RV "Polarstern" (ANT XIV/2 in November-December 1996 and ANT XIX/3 in February 2002) which were contributions to the international monitoring programme of CCAMLR (Convention on Conservation of Antarctic Marine Living Resources). Specimens were sampled with large bottom trawls in the shelf and continental slope regions of Elephant Island. Sampling depths varied from approximately 70 to 460 m, with some deeper stations in 1996 (ca. 800 m). In total 2,497 specimens were captured in November-December 1996, and 2,411 in February 2002. During both cruises *Pareledone charcoti* was the most abundant species in terms of numbers. Altogether 17 species occurred, several only recently being described. Most species belonged to the genus *Pareledone*, emphasising the extensive radiation of this endemic genus in the Southern Ocean. Both number of species and specimens increased with sampling depth, with some species concentrating in certain depth ranges. We provide new information on Antarctic octopod diversity and distribution patterns which adds significantly to Southern Ocean ecosystem studies.

Did Antarctic octopuses colonise the deep sea?

Jan Strugnell

British Antarctic Survey, High Cross, Madingley Rd, Cambridge Cambridgeshire CB30ET, United Kingdom, J.strugnell@qub.ac.uk

This study uses octopuses as model organisms to test the hypothesis that the Antarctic has acted as a centre for evolutionary innovation and radiation and as a source of taxa that have invaded the deep sea. It is likely that the deep-sea fauna was depauperate following extinction events associated with past global climate change causing, for example, deep-ocean oxygen minima. Such events have been recorded from the Late Cretaceous and Palaeocene / early Eocene, prior to the opening of the Drake Passage. The subsequent development of deep-water connections between the Southern Ocean and the major oceans which surround it would have facilitated the expansion of biogeographic boundaries. The present study characterises macro-evolutionary processes of endemic Antarctic octopod fauna and deep-sea octopod fauna using molecular methodologies. Bayesian analytical procedures incorporating fossil constraints will then be used to estimate the divergence times of these taxa thereby providing a means of testing the hypothesis that, in evolutionary history, Antarctic taxa invaded the deep sea.

Pelagic cephalopods from oceanic waters off eastern Australia: species composition and distribution determined from the diets of large pelagic fishes

Jock Young[1], Matt Lansdell[1]

[1]CSIRO Marine & Atmospheric Research, GPO Box 1538, Hobart, Tasmania, 7001, www.cmar.csiro.au, email: Jock.Young@csiro.au, Matt.Lansdell@csiro.au

Although pelagic cephalopods are one of the main faunal components of oceanic ecosystems they are also one of the most poorly understood due largely to the inability of present day sampling equipment to catch them. However, their central role in the food chain of most large pelagic predators has allowed some understanding of not only their species makeup and distribution but also that of the predators that chase them. Here we examine the composition of pelagic cephalopods from oceanic waters off eastern Australia as determined from stomach content collections made from large pelagic fishes including swordfish, striped marlin, yellowfin and bigeye tuna. We provide an overview of the cephalopod species mix together with an overview of their vertical and horizontal distributions in the region. We also compare these "stomach-derived" results with those from Midwater Opening and Closing (MIDOC) net collections from the region.

Cephalopod prey fields in relation to sperm, pilot, and beaked whale sightings off Bear Seamount and Georges Bank in 2002.

M.S. Oremland[1], M.Vecchione[1], G. Waring[2], E. Shea[1], R. Gibbons[1]

[1]NOAA Fisheries National Systematics Lab, MRC-153, Smithsonian Institution, P.O. Box 37012, Washington, DC 20013-7012. email: oremlanm@si.edu, vecchiom@si.edu, sheae@si.edu, gibbonr@si.edu

[2]NOAA Fisheries North East Fisheries Science Center, Woods Hole, MA 02543. email: Gordon.waring@noaa.gov.

In July 2002, the R/V Delaware II occupied 21 pelagic and 3 bottom trawl stations at Bear Seamount (39° 55'N 67° 30'W) and in the canyons of Georges Bank, USA. Cephalopod diversity was examined at cetacean (=slope & canyon) stations as an indication of the prey field available to the local marine mammal population. We compared the cephalopod diversity at these stations to non-cetacean (=Bear Seamount) stations to test the hypothesis that whales feed preferentially on larger and more abundant cephalopods. We collected 553 specimens in 37 species and 33 genera. Multidimensional scaling analyses showed that prey fields were similar between cetacean and non-cetacean stations, with 24 species found in common. The overall average cephalopod size was larger at non-cetacean stations, but individual species known to be cetacean prey (e.g. *Histioteuthis reversa, Illex illecebrosus*) were slightly larger at the cetacean stations. *Illex illecebrosus* was the most abundant species found at cetacean stations by far, followed by *Mastigoteuthis magna, Histioteuthis reversa, M.agassizii,* and *Abraliopsis pfefferi.* At the non-cetacean stations, *H. reversa, M. magna, Octopoteuthis sicula* and *M. agassizii and A.pfefferi* were the top five most abundant cephalopods.

Feeding habits of the blue shark *(Prionace glauca)* and salmon shark *(Lamna ditropis)* in the transition region of the western North Pacific

Tsunemi Kubodera[1], Watanabe, Hikaru[2], Taro Ichii[2]

[1] National Science Museum, Tokyo, 3-23-1, Hyakunin-Cho, Shinjuku-Ku Tokyo 169-0073, Japan, email: kubodera@kahaku.go.jp

[2] National Research Institute of Far Seas Fisheries

The stomach contents of 70 blue sharks and 39 salmon sharks caught by research drift gillnets in the transition waters of the western North Pacific in April-May during 1999-2000 were examined. The blue sharks (total lengths: 50-175 cm) fed on a large variety of prey species, including 24 cephalopods and 16 fishes; major prey included large, non-active, gelatinous, meso- to bathypelagic cephalopods and small myctophids. The salmon sharks (total length: 69-157 cm) fed on fewer prey species, including 10 cephalopods and 1 fish; major prey included mid-sized, active, muscular, epi- to mesopelagic squids. It is supposed that blue sharks feed on cephalopods mainly during the daytime when the sharks frequently descend to deep water. Salmon sharks may feed more opportunistically with no distinct feeding period. Blue sharks and salmon sharks are both apex predators in the North Pacific food web but have different feeding habits and strategies that reduce competition for food resources.

Predator-prey interactions in the Southern Ocean: Identification of growth and post-spawning periods of antarctic squids using albatross diets

J.C. Xavier[1], [2], J.P. Croxall[1]

[1]British Antarctic Survey, Natural Environment Research Council, High Cross, Madingley Road, CB3 OET, Cambridge, United Kingdom.

[2]Centre of Marine Sciences, University of Algarve, Campus of Gambelas, 8000-117 Faro, Portugal.
Contact email: JCCX@cantab.net

The life cycles of Antarctic squid are poorly known. Much information can be obtained through study of predator-prey interactions. Seasonal change in squid beak sizes can be used to ascertain the growth rates and post-spawning periods. The cephalopod diets of the wandering albatross *Diomedea exulans,* grey-headed albatross *Thalassarche chrysostoma* and black-browed albatross *T. melanophrys* were studied at South Georgia in order to identify growth and post-spawning mortality periods of Antarctic squid. We also review the cephalopod spectra, in terms of species and sizes, of albatrosses, and discuss the potential causes of prey size differences in relation to predator selectivity and prey availability. The wandering albatross, which breeds during the Antarctic winter, feeds on larger adult squid prey than those consumed by smaller albatrosses (grey-headed and black-browed albatrosses), which breed during the Antarctic summer. This potentially reflects predator adaptations (e.g. timing of breeding, foraging ecology, feeding methods) as well as prey factors. We also discuss the extent to which prey ecology and phenology influence predator-prey interactions in the Antarctic (Southern Ocean) marine ecosystem.

The diet of sperm whales, *Physeter macrocephalus*, stranded in New Zealand: Implications for conservation

Felipe Gomez-Villota

Earth and Oceanic Sciences Research Institute, Auckland University of Technology,
Private Bag 92006 Auckland 1020, New Zealand. felgom02@aut.ac.nz

The stomach contents of 19 sperm whales stranded on New Zealand beaches between 1995 and 2004 are reported. Relative to historical accounts from New Zealand waters, in which regionally occurring species of *Histioteuthis* and *Moroteuthis* dominated the whale's diet, current cephalopod beak numbers and overall diversity appear reduced. Fish and arrow squid *(Nototodarus sp.)*, once comprising up to 37% and 18.5% respectively of the diet of this whale in the 1960s, are entirely absent from the stomachs of any recently stranded whale.

Several cephalopod species preyed upon by sperm whales in New Zealand waters are recognised as endangered by New Zealand conservation agencies. Temporal shifts in the diet of this whale are a likely response to the deleterious effects of deep-sea fisheries on the habitat, distribution and abundance of important prey species. Perceived threats to the diet of sperm whales resulting from deep-sea fisheries activity in New Zealand are examined.

The diet of pygmy sperm whales, *Kogia breviceps*, stranded in New Zealand: Implications for conservation

Emma Beatson

Earth and Oceanic Sciences Research Institute, Auckland University of Technology, Private Bag 92006 Auckland 1020, New Zealand. emmbea16@aut.ac.nz

The stomach contents of 27 *Kogia breviceps* stranded on New Zealand beaches between 1991 and 2003 are reported. These individuals comprise 15 males, 10 females, and two for which no sex information is available. The diet was found to include fish and crustaceans, but is comprised primarily of cephalopods, with 0–467 lower beaks within any one stomach. Cephalopod prey is attributed to at least 30 species from 14 families, and is dominated by mature individuals of the families Histioteuthidae and Cranchiidae (adults of which usually occur at depths exceeding 400m), and the more shallow-occurring Enoploteuthidae. These are the first data reporting the diet of this whale species in New Zealand waters.

The bathymetric distribution of ontogenetic stages of the most critical species in the diet of *K. breviceps* is described, based on comprehensive museum collections from the New Zealand EEZ. Perceived threats to this whale, particularly those affecting distribution and abundance of prey species, are also discussed.

Estimation of target strength and mantle length, and behavioural observation of squids using 'in situ' acoustic-optical system

Kouichi Sawada

Fisheries Research Agency, 7620-7, Hasaki, KAMISU IBARAKI 314-0408, JAPAN, ksawada@fra.affrc.go.jp

Target strength (TS), mantle length, swimming speed, and tilt angle of Boreopacific gonate squid *(Gonatopsis borealis)* were estimated using an acoustical-optical composite system (J-QUEST). The J-QUEST consists of a quantitative echosounder and a high-sensitivity stereo video camera system installed in a housing resistant to pressure at the depth of 300m. This species is distributed in deep water in the daytime and migrate to the surface in the night-time. The J-QUEST was routinely deployed from several hours before sunset to several hours after sunset in a day from July 27 to July 30, 2004 in the North Pacific Ocean. In the daytime, Boreopacific gonate squids were seen at the J-QUEST depth of 230m. They were observed trying to capture a standard sphere suspended under the J-QUEST transducer. Swift vertical movements such as several tens of metres within over ten seconds were also observed on echogram. Estimated average TS for selected echoes was –56.1dB. In the night-time, a Boreopacific gonate squid with estimated mantle length of 37cm at the J-QUEST depth of 25m was observed preying one Japanese anchovy *(Engraulis japonicus)* in an aggregation with the average length 12.3cm. The J-QUEST was found to be an effective tool to measure TS and length, and to observe behaviour of squids 'in situ'.

Why won't my octopus come back: utilizing passive telemetry to understand the dynamics of an octopus population

Jayson Semmens, Julian Harrington

Tasmanian Aquaculture and Fisheries Institute, University Of Tasmania, Private Bag 49, Hobart TAS 7001, jayson.semmens@utas.edu.au

Traditional tag-recapture studies have long been used to examine movement of marine animals and provide an understanding of population dynamics. However, the disadvantage of these types of studies is the animals have to be recaptured to provide information. A tag-recapture program was undertaken to examine the movement and population structure/dynamics of the maori octopus *Octopus maorum* on an inshore temperate reef in Tasmania, Australia. During monthly sampling over the period of a year 49 octopus were captured in baited lobster traps and tagged with PIT tags and released. Of these tagged animals, however, only seven were recaptured, with six recaptured within a few days of their initial capture and one in the following month. This posed the question: Why were there no long-term recaptures? To help answer this question, a complex-array of passive acoustic 'listening stations' was established on the reef, such that individually tagged octopus could be identified and recorded as they moved around the reef. Twenty octopus were tagged with uniquely coded acoustic tags and tracked passively. This talk presents preliminary data from this study, which suggests that *Octopus maorum* may only be a short-term resident on reefs, explaining the low recapture rate in the initial tag-recapture study.

Determining natal origins of hatchling squids based on trace element fingerprints within statoliths

Gretta T. Pecl[1], Sean R. Tracey[2], Leonid V. Danyushevsky[3]

[1],Marine Research Laboratories, Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, Private Bag 49, Tasmania, Australia, 7001, http://www.utas.edu.au/tafi/Profiles_MRL/TAFI_Gretta_Pecl.htm, Gretta.Pecl@utas.edu.au.

[2],Marine Research Laboratories, Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, Private Bag 49, Tasmania, Australia, 7001, Sean.Tracey@utas.edu.au

[3],School of Earth Sciences and CODES SRC, University of Tasmania, Private Bag 79, Tasmania, Australia, 7001, L.Dan@utas.edu.au

Understanding the relative importance of different spawning areas in contributing recruits to fished populations is critical for ensuring resource sustainability, and an area currently poorly understood for cephalopods. Using LA-ICP-MS we assessed the potential of statolith trace elements as unique natural 'fingerprints' to identify the natal area of hatchling squid. Southern calamary hatchlings were collected from six locations, each approximately 30km apart, along the south-east Tasmanian coast. Significant differences in Fe, Sr, Mn, Ba, Mg, As and Li were consistently found among locations. Discriminant analysis demonstrated that an average of 75% of hatchlings could be re-classified back to their correct site of origin based on their trace elements. Hatchlings from the main spawning area had a very distinctive elemental fingerprint, resulting in 95% re-classification success for individuals from this region. Two sites, both with adjacent exposed coastlines, had overlapping signatures bringing down the overall classification success. Elemental fingerprints in the hatch region of adult statoliths from the same six locations can now be used to retrospectively determine their natal origins. This will allow us to explore the dispersal scale of calamary, as well as the extent of self-seeding for each area, and the degree of connectivity among local populations.

Microchemistry analysis of statoliths from neon flying squid *(Ommastrephes bartramii)* in the North Pacific

Chia-Hui Wang[1]*, Chih-Shin Chen[2]*, Wann-Nian Tzeng[1], Cheng-Feng You[3], Tai-Sheng Chiu[4]

[1]Institute of Fisheries Science, College of Life Science, National Taiwan University, Taipei 106, Taiwan, E-mail: chiahuiwang@hotmail.com

[2] Institute of Fishery Biology, National Taiwan University, Taipei 106, Taiwan
[3] Department of Earth Sciences, National Cheng Kung University, Tainan 701, Taiwan
[4] Institute of Zoology, and Department of Life Science, National Taiwan University, Taipei 106, Taiwan
*These authors contribute equally to this study.

Two geographical stocks and two seasonal cohorts of *Ommastrephes bartramii* in the North Pacific were evident in previous studies, which suggested the north-east stock was composed of relative large-sized individuals (almost all females), and most hatched in autumn, and the north-west stock which was composed of relatively small-sized individuals, and most hatched in winter. However, the population structure within the two stocks/cohorts was still unclear. In this study, we analysed the elemental compositions in the statoliths of female *O. bartramii* from two geographical stocks using high resolution inductively coupled plasma-mass spectrometry (HR-ICPMS), in attempt to understanding the structure of this species in the North Pacific. All squid were assigned to a spawning cohort based on back-calculation of daily increments within statoliths. The concentration of Na, Mg, K, Mn, Fe, Ni, Cu, Zn, Sr, Ba, Pb, and Ca were analysed and one-way ANOVA test indicated that Na/Ca, Mn/Ca, Fe/Ca, Ni/Ca, Sr/Ca ratios were significantly higher in the north-west stock. Stepwise discriminant analysis indicated that the two stocks of squid could be 100% correctly classified by the elemental composition of statoliths and the ratio of Ni/Ca, Cu/Ca, Sr/Ca, Na/Ca, and Fe/Ca play important role in the discriminating function. The effects of growth rate on relative concentration of elements were also analysed. Elemental composition in the statoliths of *O. bartramii* varied significantly in the two geographical stocks, though hatched in a similar period, which suggested they could undertake different environments during their life history of feeding migrations.

Determining connectivity of cephalopod populations using statolith chemistry

Bronwyn Gillanders[1], Melita de Vries[1], Steve Donnellan[2]

[1]School of Earth and Environmental Sciences, Darling Building DP418, University of Adelaide, SA 5005, Australia. http://www.marinebiology.adelaide.edu.au/; email: Bronwyn.gillanders@adelaide.edu.au, Melita.devries@adelaide.edu.au

[2]South Australian Museum, North Terrace, Adelaide, SA 5000, Australia. http://www.samuseum.sa.gov.au/; email: Donnellan.Steve@saugov.sa.gov.au

The giant Australian cuttlefish *(Sepia apama)* annually forms a massive breeding aggregation in northern Spencer Gulf in South Australia. Whether juveniles that hatch from eggs found at the site of the breeding aggregation return there to breed as adults is unknown, but knowledge of this is vital for management of the species. The objective of this study was to assess whether statolith chemistry could be used to determine connectivity of cephalopod populations. Hatchlings were collected just prior to hatching from locations inside and outside the breeding aggregation and their statoliths analysed using laser ablation inductively coupled plasma-mass spectrometry (LA ICP-MS). Significant differences in trace elements were found among locations. The statolith chemistry of adult cuttlefish collected from the breeding aggregation was then analysed. Using maximum likelihood analyses the proportion of cuttlefish originating as juveniles from inside the breeding aggregation was then determined. Results from this study will then be used to make recommendations regarding the establishment of a marine protected area.

Spatial patterns in key biological features of the chokka squid, *Loligo vulgaris reynaudii* on the Agulhas Bank, South Africa

L.J.H. Olyott[1], W.H.H. Sauer[2], A.J. Booth[2]

[1] Department of Primary Industries and Fisheries, Queensland, GPO Box 46, Brisbane, Qld, 4001, Australia http://www.dpi.qld.gov.au/fishweb/, email:leonard.olyott@dpi.qld.gov.au

[2]Department of Ichthyology and Fisheries Science, Rhodes University, P.O. Box 94, Grahamstown, 6140, South Africa

Although migration patterns for various life history stages of the chokka squid *(Loligo vulgaris reynaudii)* have been previously presented, limited comparison of spatial variation in biological parameters has been investigated. Using data from both fishery dependent and independent sources, size ranges of juveniles, subadults and adults on the Agulhas Bank were estimated and distribution patterns displayed using a Geographical Information System. Adult chokka were predominantly inshore and in the east, juveniles inshore in the east and offshore in the west, and immature squid showing an intermediate distribution pattern. Catches of adult animals in deeper water, particularly in autumn in the central study area, were not uncommon and may represent deeper spawning squid. This paper provides further support to the hypothesis of an annual pattern of at least a portion of the population hatching in the east, migrating westwards to offshore feeding grounds on the Central and Western Agulhas Bank and the west coast of South Africa and a subsequent return migration to the eastern inshore areas to spawn. The lack of clear spatial patterns in other biological parameters such as length-to-weight relationships and gonadosomatic indices suggests that a far more complex migration pattern may exist than originally hypothesised. Further research is required to investigate the possibility of a separate population structure on the Western Agulhas Bank and West Coast of South Africa, and into the possibly of forecasting within season recruitment strength from the sub-adult section of the population.

Egg balloon masses discovered in the Agulhas Current (South Africa) challenge contemporary wisdom and suggest the possibility of an ommastrephid squid fishery in the region

M. J. Roberts[1], P. Penven, A. Connell

[1]Marine Coastal Management, Private Bag X2, Roggebaai, Cape Town, Western Cape 8012, South Africa, email: squid@metroweb.co.za

Unlike the other four western boundary currents, the Agulhas Current does not support a major ommastrephid squid fishery. Contemporary hydrodynamic model results and *in situ* hydrology indicate that the tropical source of the Agulhas Current is a complex inflow of anticyclonic and cyclonic eddies which move slowly southwards down the Mozambique Channel and westwards from Madagascar. This is unique and prevents the fast, straight-forward, poleward transport of biological material such as squid egg balloons. The consequent shortened Agulhas Current and unreliable southwards delivery of squid egg balloons are primary reasons cited for the lack of a major ommastrephid fishery off the south-eastern African continent. In July 2005, however, distinctive ommastrephid squid egg balloons were observed by SCUBA divers on the narrow Kwa-Zulu Natal shelf. The photographed egg masses were in shallow water (40 m) about 5-10 m above the bottom. A strong thermocline existed at the level of the egg masses with clear water below. Bottom temperature was 18°C with the surface estimated at 21°C. Hydrological data show that 18°C water is usually found at a depth of 100–120 m in this region, which is well away from the coast. SST satellite imagery at the time showed a cyclonic eddy embedded in the shoreward boundary of the Agulhas Current near the discovery site. Recovered data collected by an underwater temperature recorder (UTR) located 4 km away showed a drop in the bottom temperature to 18°C indicating shelf edge upwelling. These data indicate that the egg balloons are ordinarily transported at a depth of ~120 m (density surface) along the continental shelf and that the upwelling event enabled the chance discovery. Current velocities at 120 m have been measured at ~ 1 m s^{-1} which suggests the place of spawning is about 1,200 km upstream of the discovery site in the southern region of the Mozambique Channel. Spawning will involve mass aggregations of this ommastrephid squid, which may support a fishery?

First-ever observations of a live giant squid in the wild

Tsunemi Kubodera, Kyoichi Mori

Department of Zoology, National Science Museum, Tokyo & Ogasawara Whale Watching Association
email: kubodera@kahaku.go.jp

The giant squid, *Architeuthis,* is renowned as the largest invertebrate in the world and has featured as an ominous sea monster in novels and movies. Considerable efforts to view this elusive creature in its deep-sea habitat have been singularly unsuccessful. Our digital camera and depth recorder system recently photographed an *Architeuthis* attacking bait at 900 meters off Ogasawara Islands in the North Pacific. Here we show the first wild images of a giant squid in its natural environment. Recovery of a severed tentacle confirmed both identification and scale of the squid (>8 m). *Architeuthis* appears to be a much more active predator than previously suspected, using its elongate feeding tentacles to strike and tangle prey.

Conservation of Hox genes among molluscs: the cephalopod exception

Mathieu Pernice, Jean S. Deutsch, Aude Andouche, Renata Boucher-Rodoni, Laure Bonnaud

UMR 5178, Muséum National D'Histoire Naturelle, CP51, 55 Rue Buffon, Paris Ile De France 75005, France
email: Pernice@mnhn.fr

Hox genes are known to be involved in the patterning of the body along the anterior-posterior axis through bilaterian phyla. Among the Lophotrochozoa, molluscs are a group of particular interest because of their body plan diversity. In the present study, we have isolated 14 Hox genes representing nine different paralogues from three cephalopod species: *Sepia officinalis, Nautilus pompilius* and *Nautilus macromphalus.* We compared our data with available homeodomain sequences from other molluscs and metazoans. Orthology was determined for each sequence obtained. The central part of certain Hox cephalopod genes exhibits specific features, i.e. signatures of the phylum Mollusca. Small changes in amino acids sequence were observed within the molluscs thus providing information about the evolution of this group. Based on similarity between gastropod and *Nautilus,* we propose the sequences of *Nautilus* Hox genes as the ancestral form of the Mollusca and a number of ten to eleven Hox genes in the mollusc ancestor. Changes in the Decabrachia lineage, as suggested by *Sepia* and *Euprymna* gene similarities, might be related to modifications in developmental mechanisms. These changes in the otherwise so conserved central part of the Hox homeodomain among bilaterians, constitute what we call 'the cephalopod exception'.

Issues in oegopsid phylogenetics: can molecular data help to further resolve relationships within *Oegopsida?*

Annie Lindgren

Ohio State University, Department of Evolution, Ecology, and Organismal Biology, Columbus Ohio 43212, Museum of Biological Diversity, 1315 Kinnear Road, United States, lindgren.11@osu.edu

The suborder Oegopsida (Cephalopoda: Teuthida) is an elusive and morphologically diverse group of cephalopods whose phylogenetic relationships remain unclear. Several factors, including a paucity of information regarding character evolution between oegopsids, loliginids and sepioid decapodiforms make it difficult to determine polarity of morphological features within Oegopsida. Additionally, Decapodiformes likely underwent a rapid radiation during the Mesozoic, confounding attempts to establish homologies for both morphological and molecular data. The present study incorporates data from 5 molecular loci (18S rRNA, 28S rRNA, Histone H3, cytochrome oxidase subunit I, and 16S rRNA) for approximately 60 taxa representing 29 decapodiform families and 48 genera in order to address the evolutionary relationships within Oegopsida, the phylogenetic position of Oegopsida relative to Myopsida, the potential monophyly of Teuthida, and the relationship of Myopsida, and Oegopsida to the sepioid families. Because this analysis is the most comprehensive to date in terms of taxonomic scope and genes considered, it also provides an opportunity to investigate the role of molecular data in cephalopod phylogenetics.

Phylogeny and population genetics of *Alloteuthis* (Loliginidae) and discovery of a cryptic species

F.E. Anderson[1], V. Laptikhovsky[2], A. Pilsits, G. Bello

[1]Department of Zoology, Southern Illinois University, Carbondale Illinois 62901, United States, feander@siu.edu

[2] Falkland Islands Fisheries Department, P.O. Box 598, Stanley Falkland Islands Fiqq 1zz, Falkland Islands (Islas Malvinas), vlaptikhovsky@fisheries.gov.fk

Alloteuthis is a clade of small loliginid squids comprising three nominal species—*Alloteuthis africana, Alloteuthis media*, and *Alloteuthis subulata*—found in the Mediterranean and eastern Atlantic. Laptikhovsky and coauthors have suggested that *A. media* and *A. subulata* are different growth stages of a single species, and thus should be synonymized. To test this hypothesis, we collected representatives of all three putative species from several Atlantic and Mediterranean localities, ranging from Angola to the English Channel and east to the Aegean, for a molecular phylogenetic study. Analyses of partial COI and 16S sequences reveal three strongly supported clades that do not correspond to the three traditionally recognized *Alloteuthis* species. The clades include an Angolan/Mauritanian group (referable to *A. africana)* and a large group found throughout the northeast Atlantic and Mediterranean (referable to *A. media* + *A. subulata)*, as well as a small clade represented thus far only by several specimens collected from the southwestern Adriatic. These specimens are morphologically indistinguishable from other *"A. media"* specimens collected from the same area. We suggest that this clade represents a cryptic *Alloteuthis* species that has arisen within the Mediterranean. Future work may reveal morphological characters that will allow a formal description of this species.

Genetic diversity of isolated populations of *Nautilus pompilius* in the Coral Sea

Billy Sinclair

Marine Molecular Genetics and Biotechnology Group, School of Biological and Environmental Sciences, Central Queensland University, Rockhampton, Queensland 4701, Australia. http://ahs.cqu.edu.au/schools/biolenv/Marine_Genetics.htm b.sinclair@cqu.edu.au

One of the oldest species inhabiting the oceans, *Nautilus* are the only remaining cephalopods with an external shell. In prehistoric times, nautiloids and ammonoids were one of the dominant marine predators, both in terms of number of different species and the numbers of animals. Today, *Nautilus* are heavily targeted across their range to supply the increasing demand of the shell trade – they are not under the protection of CITES listing. Widely distributed, the population structure, genetic stratification and spatial movements of these animals are essentially unknown. Over a number of years, an ongoing study has been examining the demographics and morphological assessments of *Nautilus* populations inhabiting sea mounts in the coral sea and adjacent to the northern section of the Great Barrier Reef. A number of individuals from each of these same populations have been sampled, for the first time, the inter- and intra-population genetic diversity examined using PCR-based molecular markers and DNA sequencing. Results of this examination will be presented and discussed in relation to the parameters above.

Genetic and morphological identification of *Onykia* paralarvae from Northern Hawaiian and western Pacific waters

Wakabayashi Toshie[1], Tsunemi Kubodera[2], Taro Ichii1, Mitsuo Sakai[1], Seinen Chow[3]

[1] National Research Institute of Far Seas Fisheries, 4-5-7 Orido, Shimizu-ku, Shizuoka-shi, Shizuoka, 424-8633 Japan, email: toshiew@fra.affrc.go.jp

[2] National Science Museum, 3-23-1 Hyakunin-cho, Shinjuku-ku, Tokyo, 169-0073 Japan

[3] National Research Institute of Fisheries Science, 6-31-1 Nagai, Yokosuka-shi, Kanagawa, 283-0316 Japan

Most *Onykia* species may actually represent an immature stage of species in the genus *Moroteuthis.* To identify *Onykia* species paralarvae (1.8–12.9 mm dorsal mantle length [ML]) from northern Hawaiian waters and the western Pacific, we performed morphological characters and nucleotide sequence analysis of the mitochondrial cytochrome oxidase I (COI) gene. Two *Onykia* species were distinguished in samples from northern Hawaiian waters. One species was identified as *M. robusta,* but the other *(Onykia sp. A)* could not be assigned to any *Moroteuthis* species. Percentage of nucleotide substitution between *Onykia* sp. A and *Moroteuthis* species ranged from 9.9 to 13.6%. Paralarvae of *M. robusta* smaller than 4.0 mm DML were distinct from other *Onykia* paralarvae in the chromatophore pattern of the mantle. In the western Pacific samples, two species were also determined. One species was assigned to *M. lonnbergii,* but the other (*Onykia* sp. B) was not identified to any *Moroteuthis* species. Percentage of nucleotide substitution between *Onykia* sp. B and *Moroteuthis* species ranged from 8.9 to 17.5% and that between *Onykia* sp. A and B was 11.3%. The percentage of nucleotide substitution between species within the genus *Moroteuthis* ranged from 11.5 to 20.5%, suggesting that *Onykia* sp. A and B are paralarvae of genus *Moroteuthis.*

Squids of the family Gonatidae – genetic relationships and life cycle strategies

O.N. Katugin[1], A.R. Lindgren[2], E. Amezquita[3], M.K. Nishiguchi[4]

[1] Pacific Research Fisheries Centre (TINRO-Centre), 4 Shevchenko alley, Vladivostok 690 950, Russia, okatugin@mail.ru, katugin@tinro.ru

[2] The Ohio State University, Department of Evolution, Ecology and Organismal Biology, 1315 Kinnear Road, Columbus, OH 43212, lindgren.11@osu.edu

[3],[4] Department of Biology, MSC 3AF, New Mexico State University, PO Box 30001, Las Cruces, NM 88003-8001, nish@nmsu.edu

The Gonatidae is a teuthid family consisting of approximately 20 species, which present different modes of life. Allozymes and mitochondrial DNA loci (12S rRNA, 16S rRNA, and cytochrome *c* oxidase subunit I) revealed highly compatible patterns of genetic relationships among morphologically distinguishable taxonomic units (MDTU) within the Gonatidae. Two major evolutionary trends within the family have been suggested based on the genetic approach. One is demonstrated by the Gonatidae with seven longitudinal rows of radular teeth and muscular body. This group encompasses small numbers of MDTU living only in the North Pacific Ocean and showing no evidence of egg-brooding. A separate lineage includes the Gonatidae with five longitudinal rows of radular teeth and a less muscular body. This group encompasses at least twice as many MDTU living in the North Pacific, North Atlantic, and Southern oceans. Females of (at least some of) representatives of this evolutionary lineage undergo degeneration of muscular tissues upon maturation and brood their eggs between arms. Genetic analyses using combined analysis of data provided deeper insight into systematic relationships and phylogenetic trends within the Gonatidae, particularly concerning their reproductive ecology and behavior.

Species complex of *Octopus minor* (Cephalopoda: Octopodidae) from Taiwan waters, including two new species

Cheng-Hua Chang

Graduate Institute of Ecology and Environmental Education, National, 123 Hua-His, Hualien Hualien 970, Taiwan, email: cch@mail.nhlue.edu.tw

Octopus minor (Sasaki, 1929) is a commercially important species in Japan. It is also found in waters of Taiwan and China. *O. minor* has elongate arms with the dorsal pair longest, a feature characteristic of *O. macropus* group. Sasaki (1929) reported three varieties of *O. minor: O. minor typicus, O. minor pardalis* and *O. minor minor* from Japanese waters. Here we found three entities of *O. minor* complex from Taiwan waters based on morphological and molecular evidence. One is *O. minor typicus* from north-eastern waters of Taiwan and the other two species are recognized as new species: *O.* sp. nov. TW10 and *O.* sp. nov. TW33 which are distributed in the intertidal zone of Peng-hu islands in western waters of Taiwan and south-western waters of Taiwan respectively. They are similar with respect to the funnel organ, big copulatory organ and big eggs but distinguished from each other and other varieties of *O. minor* by color pattern, the smallest mantle length at maturation, the ratio of copulatory organ and dorsal mantle length, and the normal sucker number of the hectocolylus arm. The molecular data of partial mitocondrial cytochrome *c* oxidase subunit I DNA sequences also indicate the close relationship but distinct species status of these three taxa.

Deep-sea pelagic cephalopods of Bear Seamount

E.K. Shea[1], M. Vecchione, [1]

[1]NOAA Fisheries National Systematics Lab, MRC-153, Smithsonian Institution, P.O. Box 37012, Washington, DC 20013-7012, email: sheae@si.edu, vecchiom@si.edu

Seamounts are biological foci in the deep sea that are notoriously difficult to sample. The biota associated with Bear Seamount (39° 55'N 67° 30'W), the most inshore of the New England Seamounts, was poorly known until the NOAA R/V Delaware II began a series of exploratory cruises designed to document the biotic diversity of Bear seamount and the NE Continental Slope. Six cruises (DE0011, DE0206, DE0304, DE0408, DE0409, and DE0506) have collected cephalopods from 128 midwater trawls and 63 bottom trawls at the seamount summit, slopes and base. We collected 1,328 individual cephalopods from 55 species in 42 genera in the midwater trawls, and 411 individuals from 34 species in 29 genera in the bottom trawls. Specimens were measured, identified and entered into NOAA's FSCS database. The most abundant species collected were: *Illex illecebrosus, Mastigoteuthis magna, Histioteuthis reversa, M. agassizii, Haliphron atlanticus,* and *Brachioteuthis* sp. Multidimensional scaling of pelagic fauna showed no difference between hauls taken inshore, over the summit, and offshore of Bear. No seamount endemics have been identified, but species accumulation curves for squids and octopods are not asymptotic.

Population dynamics of a sepiolid squid-*Vibrio* mutualism from the Indo-west Pacific

Michele K. Nishiguchi, Bryan W. Jones

Department of Biology, New Mexico State University Box 30001, MSC 3AF,
Las Cruces, NM 88003-8001 USA nish@nmsu.edu

The sepiolid squid-*Vibrio* mutualism is an excellent system for examining mechanisms of cospeciation and host tracking patterns among a wide variety of symbiotic squid species. Currently, we are using genetic diversity and nested clade analyses to examine the variation between three allopatric *Euprymna* squid species: *Euprymna scolopes* (Hawaii), *E. hyllebergi* (Thailand), and *E. tasmanica* (Australia). Using the cytochrome c oxidase subunit I locus for host squid species, and the glyceraldehyde phosphate dehydrogenase *(gapA)* locus for *Vibrio* symbionts, we have determined the genetic relatedness of these partners in the Indo-west Pacific as well as the phylogeography and fixation indices between populations of both squids and symbionts. Patterns of host specificity are predominant among symbiont genotypes and their phylogeography, but there is also some evidence of strain variation, which might preclude that squid populations are not the only driving force for selection of symbiont speciation.

Resolution and origins of the octopods

Mark Norman
Museum Victoria, Victoria, Australia
email: mnorman@museum.vic.gov.au

The octopuses are a large and incredibly diverse order of cephalopods. This rich fauna remains poorly known, with a large number of taxa being undescribed. It is likely that the number of undescribed taxa exceeds the number of described taxa. This fauna shows a wide diversity in form, behaviour and ecological niches. Recent research has discovered many new genera, particularly in the deeper waters of the southern Pacific and Indian Oceans. Molecular studies by Guzik and Strugnell have provided new insights into the origins and relationships amongst the octopuses. Subdivision of the catch-all genus *Octopus* is supported and a number of old generic names have been resurrected and new genera coined, such as *Microeledone, Thaumoctopus* and *Galeoctopus.* Additional new genera have been recognised and are currently being described. Links have been found between endemic southern Australian coastal octopuses (*O. australis, O. berrima* and *O. pallidus*) and the deep-water genus *Scaeurgus.* The widely distributed reef octopus (*Octopus cyanea*) shows strong links to the intertidal drop-arm octopuses of the genus *Abdopus,* not the morphologically similar *Octopus vulgaris* clade. Diversity and origins of the blue-ringed octopuses are discussed along with the biogeography of other major genera.

Demersal cephalopod assemblages and diversity off the northeastern coast of Greece (NE Mediterranean)

Eugenia Lefkaditou
Hellenic Centre for Marine Research, Aghios Kosmas, Heliniko, Athens Attiki GR-16604, Greece.
email: teuthis@ath.hcrnr.gr

This work aims to contribute to the knowledge of cephalopod assemblages in the eastern Mediterranean. The community structure and diversity of cephalopods were studied in the northernmost regions (Thermaikos Gulf, Peninsula of Chalkidiki, Strymonikos Gulf and Thracian Sea) of the Aegean Sea (NE Mediterranean), based on seasonal trawl surveys carried out from November 1992 to August-September 1993. Hauls were performed by a commercial bottom trawl net with 16 mm (from knot to knot) mesh size at the cod end, at depths from 17 to 400 m.

In all, 27 species of cephalopods belonging to 7 families were identified, including 5 oegopsid squids, 3 myopsid squids, 7 incirrate octopods, 3 cuttlefishes and 9 sepiolids. Multivariate analyses of species abundance data (individuals / trawling hour) showed a variability in assemblage structure determined primarily by depth, and in a lesser extent, by geographical location and season. The faunistic bathymetric gradient showed a continuous succession of species with depth rather than discrete assemblages separated by distinct boundaries. Mean species richness and diversity were higher on the shelf break than in the upper slope, the middle continental shelf and coastal zone, similarly to what has been observed for cephalopods in the western Mediterranean. Indicator species for the different bathymetric zones where more or less the same with those noted from the central and western Mediterranean Sea, except for the upper slope. The scarcity of semi pelagic squids on the upper slope and their substitution by octopods and sepiolids, is probably due to the topography of the area investigated.

Description of paralarval *Architeuthis* and Onychoteuthidae squid (Cephalopoda: Teuthoidea) from New Zealand waters.

S. O'Shea[1], C.C. Lu[2], M.C. Clarke[3]

[1]Earth and Oceanic Sciences Research Institute, Auckland University of Technology, Private Bag 92006 Auckland 1020, New Zealand. soshea@aut.ac.nz

[2]Department of Life Sciences, National Chung Hsing University, 250 Kuo Kuang Road, Taichung, Taiwan 402. cclu@dragon.nchu.edu.tw

[3]'Ancarva', Southdown, Millbrook, Torpoint, Cornwall PL10 1EZ, England.

The morphology and temporal, geographic, and bathymetric distribution of 17 paralarval *Architeuthis,* mantle length 2.42–8.75 mm, are described from New Zealand waters. These paralarvae represent the first positively identified *Architeuthis* paralarvae from New Zealand waters, and the smallest paralarvae thus far known. *Architeuthis* paralarval morphology is compared to that of morphologically similar species of the family Onychoteuthidae, particularly species referred to *Moroteuthis* and *Onychoteuthis* and *Ancistroteuthis,* and contrasted with those of other regionally occurring squid families.

Review of the systematics, diversity, and spatial and temporal distribution of the New Zealand onychoteuthid fauna

K.S. Bolstad

Earth and Oceanic Sciences Research Institute, Auckland University of Technology, Private Bag 92006 Auckland 1020, New Zealand. kbolstad@aut.ac.nz

Onychoteuthid squids are among the most common cephalopods found in New Zealand waters, and comprise a major portion of the regional diets of teuthophagous marine mammals. Although several recent publications have addressed aspects of various species biology and reproduction, the systematics of the group remains poorly understood. Herein the ontogenetic and adult morphologies of regionally occurring species of the genus *Moroteuthis* are redescribed and compared to those of other regionally occurring small-bodied onychoteuthids provisionally or historically attributed to the genera *Ancistroteuthis, Onychoteuthis, Walvisteuthis* and *Chaunoteuthis.* Particular attention is given to ontogenetic and sexually dimorphic variation in characters and character states associated with body proportions, and beak, radular, tentacular hook, and gladius morphology; additionally, palatine tooth morphology is described for the first time.

Taxonomic review of *Argonauta cornuta*, Conrad 1854 (Cephalopoda)

Andrés González Peralta

Universidad Autónoma de Baja California Sur, Departamento de Biología Marina,
Apartado postal 19-B, CP 23080

La Paz, B.C.S, México, email: aperalta98@prodigy.net.mx

Taxonomy of the family Argonautidae is uncertain because of the 39 species described; only 7 have the status of valid species. Robson in 1932 made a series of taxonomic amendments including the synonym *Argonauta expansa,* Dall 1872 in *Argonauta cornuta,* Conrad 1854. Samples of *Argonauta* were sampled from 1997 to 2005 (N=471) and after revision we found two morphotypes, although the provisional identification was *A. cornuta.* This work tests the hypothesis that *Argonauta expansa* and *Argonauta cornuta* are valid species. For this research, in addition to 471 examples collected on the field, shells and animals deposited at the Santa Barbara Museum of Natural History (SBMNH) and personal collections were examined. Different measures were taken from the shells, such as shell length, shell width, aperture width (milimetres) and weight (grams) to make evident possible differences between the species. An analysis of discriminate functions was performed, and clearly separated the morphotypes, as 90% of the specimens were correctly classified. Additionally, radulae and beaks were dissected to support the previous observations. The results indicated a clear difference in the shape between *A. expansa* and *A. cornuta,* and the possible existence of more than one species in the revised material.

Isolation and phylogenetic analysis of bacteria with antimicrobial activities from excretory organs of nautilus

Mathieu Pernice

UMR 5178, Muséum National D'Histoire Naturelle, CP51, 55 Rue Buffon,
Paris Ile De France 75005, France, email: pernice@mnhn.fr

The aim of this study was to identify and characterize bacteria with antimicrobial activities from the excretory organs of the two cephalopods *Nautilus pompilius* and *Nautilus macromphalus.* Various complementary methods were used for bacterial identification such as: culture on selective media and Gram staining for the classical approach, and 16S rDNA amplification by Polymerase Chain Reaction, Restriction Fragment Length Polymorphism and sequencing of the 16S rDNA gene for the molecular approach. The *Nautilus* isolates were affiliated with Gamma-proteobacteria, Actinomycetales and Flavobacteriales. In order to screen active strains and characterize active compounds, antimicrobial activity was tested by diffusion agar assay against *Micrococcus luteus* (Gram positive) and *Escherichia coli* (Gram negative). The *Nautilus* isolates show antimicrobial activities against both Gram-positive and Gram-negative reference strains with a stronger inhibition zone against Gram negative. Isolates with antimicrobial activity were numerically most abundant in the *Vibrionales* genera. Analyses are presently underway in order to characterize the active substances produced. The recovery of strains with antimicrobial activity suggests that cephalopods represent an ecological niche which harbours a largely uncharacterized microbial diversity and, concomitantly, a yet untapped metabolic potential.

Hearing in octopus

Kenzo Kaifu, Susumu Segawa, Kotaro Tsuchiya

Tokyo University of Marine Science & Technology, Konan, Minato, Tokyo 108-8477, Japan
email: k.kaifu@mx9.ttcn.ne.jp

Since the existence of hearing ability in cephalopods was proved in 1990, there have been few studies about hearing in cephalopods even though sound waves give much information to many marine animals. Employing classical conditioning technique, responses of *O. vulgaris* and *O. ocellatus* to sound waves at various frequencies were compared. The sensitivity to sound stimulus was determined by the difference of respiratory cycle between before and after the stimulus. In conditioning, sound waves of 160±5dB (0dB re 1Pa) and electric shocks (3V d.c.) were used as conditioned and unconditioned stimuli, respectively. Conditioned *O. vulgaris* showed response to the sound stimuli at the frequency of 50 and 100Hz, though unconditioned *O. ocellatus* reacted to 50, 100 and 150Hz, moreover, a conditioned *O. ocellatus* responded to 300Hz. Conditioned *O. ocellatus* frequently retracted the basal parts of its eyes and/or conceal itself deep in a shell when it was exposed to sound stimulus while *O. vulgaris* did not show this behavior. We surmise that the disparity among two species in sensitivity and response to sound stimulus is caused by the differences in their behavior and environmental factors, such as predation pressure.

Spatial distribution pattern of sympatric tropical octopuses in the coastal waters of the Ryukyu Islands

Natsumi Kaneko, Yuzuru Ikeda

University of the Ryukyus, Senbaru 1 Nishihara Okinawa Japan, 9030213, k058554@eve.u-ryukyu.ac.jp.

The spatial distribution pattern of tropical octopuses inhabiting the intertidal zone of the Ryukyu Islands, Japan, was investigated during low tide spring between November 2004 and February 2005 with a surveyed area of about 0.7 km^2. The location of octopuses in the surveyed area was determined by global positioning system (GPS) and they were mapped by geographical information system (GIS). Nine octopus species (*Octopus laqueus, O. ornatus, O. aspilosomatis, O. luteus, O. cyanea, Octopus* sp. A-C, *Hapalochlaena lunulata*) were collected simultaneously. *O. laqueus, O. ornatus,* and *H. lunulata,* were encountered throughout the survey. Small species (ML< 30 mm), *O. laqueus* and *H. lunulata*, were in close proximity and they were usually distributed < 20 m from their nearest conspecifics; 17 individuals were seen on one occasion. In contrast, large sized species (ML> 100 mm), *O. ornatus,* was solitary in most cases. Eberhardt index of dispersion (I_E) showed that *O. laqueus* and *H.lunulata* were aggregated (*O. laqueus*, I_E= 1.4092; *H. lunulata*, I_E= 1.6478). The present results could indicate possibility that small tropical octopus species form clumped aggregations.

Antarctic cephalopods – biodiversity and the census of antarctic marine life

Victoria Wadley, Michael Stoddart

Census of Antarctic Marine Life, Australian Antarctic Division, 203 Channel Highway, Kingston TAS 7050, Australia www.caml.aq victoria.wadley@aad.gov.au, www.caml.aq michael.stoddart@aad.gov.au

The Census of Marine Life (CoML) is a 10-year international study of the past, the present and the future of the world's oceans. With 17 field projects supported by the Alfred P Sloan Foundation, the CoML seeks to develop a level of understanding of the Earth's oceans that will enable better predictions to be made about the future of its biodiversity. The Census of Antarctic Marine Life (CAML) is one of the field projects, focused on the biodiversity of the Southern Ocean and the waters around Antarctica. The CAML is a cooperative international program that will investigate variability in the distribution and abundance of Antarctica's marine biodiversity. A central question is how biogeography is related to environmental change. Understanding the pelagic ecosystem — including cephalopods — of the Southern Ocean is an important component of the project, which takes an integrated approach to the water column and the benthos. The methods of CAML are to provide project management, workshops and data integration via the SCAR-MarBIN node of OBIS, together with education and outreach activities. As a lead project during the International Polar Year 2007/08, CAML's field sampling will include areas that have not previously been visited and overlooked groups of organisms. In addition to traditional taxonomy, the use of innovative technologies, including powerful new genetic and molecular tools, will determine the extent to which the circum-Antarctic marine fauna and flora is responding to change. The CAML is inclusive, inviting contributions from all participants and ships with capacity in Antarctic biogeography. This paper describes the progress of CAML during its first year, and outlines the field and other activities for the future.

Sex change or intersexuality?: nidamental glands in males of the oceanic squid *Ancistrocheirus lesueurii*

[1]* H.J.T. Hoving, [2] M.A.C. Roeleveld, [3] M.R. Lipinski, [1] J.J. Videler

[1]Biological Centre, Department of Marine Biology, University of Groningen, P.O. Box 14, 9750 AA Haren (Gn), The Netherlands; e-mail: H.J.T.Hoving@rug.nl; J.J.Videler@rug.nl

[2]Iziko Museums of Cape Town, P.O. Box 61, Cape Town 8000, South Africa; e-mail: Martina@iziko.org.za

[3]Marine and Coastal Management, Private Bag X2, Roggebaai 8012, Cape Town 8000, South Africa; e-mail: Lipinski@deat.gov.za
*Corresponding author

This is the first record of intersexuality to have been found within the Cephalopoda. Seven out of 16 sexually mature *Ancistrocheirus lesueurii* males from southern African waters had nidamental glands in the mantle cavity in addition to a normally developed male reproductive system (spermatophoric complex, testis and hectocotylus). The frequency of occurrence suggests that feminisation in male *A. lesueurii* is not a rare phenomenon in the southeastern Atlantic. Normal *A. lesueurii* shows sexual size dimorphism, with females growing larger than males. The intersexual males formed a distinct size group intermediate between normal males and females, and their testis mass and spermatophore length were significantly larger than in normal males. The absence of oocytes and oviducts in intersexual males indicates that feminisation represents pseudohermaphroditism. Intersexuality does not seem to affect male functionality and is apparently advantageous in that larger body size is accompanied by a larger testis and spermatophores.The cause of intersexuality in the species is discussed.

Life history of *Loligo vulgaris* on the shelf of the Thracian Sea (NE Mediterranean)

Eugenia Lefkaditou
Hellenic Centre for Marine Research, Aghios Kosmas, Heliniko, Athens Attiki GR-16604, Greece.
email: teuthis@ath.hcrnr.gr

The reproductive biology and growth patterns of *Loligo vulgaris* are described from monthly samples taken from bottom trawl and beah-seine fisheries (February 1992-June 1993) in the Thracian Sea. The analysis of maturity stages monthly frequency and the evolution of gonadosomatic index showed that female spawning is lasting from February to June with maximum occurrence of fully mature females in April, whereas, spermatophore laying begins in December getting more intensive by March. The relatively shorter duration of spawning period in the Thracian Sea in comparison to that observed in different areas of the Mediterranean Sea and the Atlantic Ocean could be probably attributed to the stronger seasonal variation of temperature over the shallow spawning grounds of the species in the studied area. The estimated number of oocytes in mature females varied from 677 to 30,174, increasing with body size. Male reproductive output varied between 115 and 505 spermatophores. The life span of *L. vulgaris* was estimated at about 1year in consistency with results from other areas. Growth rates differed significantly between the two sexes, with males attaining larger sizes than females of same age. Significant differences were also revealed in growth rates of females with different hatching period. The diet of *L. vulgaris* comrised of fish (70%) and cephalopods (30%).

Spermatophore formation in Loliginidae: morphology, histology and histochemistry of the spermatophoric organ of *Loligo plei, L. sanpaulensis* and *Lolliguncula brevis*

José E.A.R. Marian[1], Osmar Domaneschi[1]

[1]Laboratório de Malacologia, Instituto de Biociências, Universidade de São Paulo. Rua do Matão, 101 - Travessa 14, 05508-900, São Paulo, SP, Brazil, email: jeduardo_marian@yahoo.com.br, domanesc@ib.usp.br

The spermatophoric organ consists of a series of glands and structures responsible for spermatophore elaboration. Few works have been done on the functional anatomy of the loliginid spermatophoric organ and several questions concerning it remain unsolved; therefore it has been highlighted in the literature the need for detailed microscopic anatomical data of the whole organ. The aim of this study is to investigate the spermatophoric organs of the loliginids *Loligo plei* Blainville, 1823, *L. sanpaulensis* Brakoniecki, 1984 and *Lolliguncula brevis* (Blainville, 1823) applying morphological, histological and histochemical techniques, as well as the spermatophore formation in live anesthetized *L. plei* specimens collected by jigging off the coast of São Sebastião, State of São Paulo, Brazil. The spermatophoric organ of these three species is composed of mucilaginous glands I and II, ejaculatory apparatus gland, middle tunic gland, outer tunic gland, accessory gland and appendix of accessory gland, the whole organ being enclosed by the genital sac, as reported in the literature for other loliginids. The structure, microanatomy and histochemistry of the spermatophoric organ are described in detail and compared within the Loliginidae; the functional anatomy of the organ is discussed in light of these new data.

Dimorphism in sperm investment patterns associated with alternative mating tactics in the squid *Loligo bleekeri*

Yoko Iwata[1], Yasunori Sakurai[2]

[1]Graduate School of Fisheries Sciences, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido 041-8611, Japan, email: iwayou@fish.hokudai.ac.jp

[2]Graduate School of Fisheries Sciences, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido 041-8611, Japan, email: sakurai@fish.hokudai.ac.jp

Dimorphism within males is common in species that show alternative reproductive behaviors associated with the difference of body size. These behaviors can lead to asymmetry in sperm competition risk, and sperm competition theory predicts that this asymmetry will lead to differences in reproductive investment, such as differences in sperm release tactics and testis size. In this study, we examined dimorphism associated with body size in external characters (six body parts) and internal characters (spermatophore length and testis weight) in mature males of the squid *Loligo bleekeri.* Males of this species show alternative mating tactics by passing spermatophores to different sperm storage sites in females. The size distribution of matured males showed a uni-modal pattern in our samples, and analyses of allometric patterns found no dimorphism in the external characters. However, the two internal characters showed discontinuous increases associated with increasing mantle length. In the small males (ML < 206 mm), the spermatophores measured 8.6-10.5 mm and the testis weighted about 1 g, while in the larger males (ML > 206 mm), the spermatophores measured 12.8-18.3 mm and the testis weighted about 2.5 g. These discrete patterns suggest that internal male morphological traits might change as males adopt alternative mating tactics.

Estimating the growth of deep sea squid through an individual-based model approach: without and with energetics constraints

Eric P.M. Grist[1], George D. Jackson[2], Elizabeth A. Fulton[1]

[1]CSIRO Marine and Atmospheric Research, GPO Box 1538, Hobart, Tasmania, Australia, email: eric.grist@csiro.au

[2]Institute of Antarctic and Southern Oceanic Studies, Private Bag 77, University of Tasmania, Hobart, Tasmania 7001, Australia.

Laboratory culture work has suggested that cephalopod growth in general occurs rapidly and is closely tied to temperature throughout a short lifespan. In the case of deep sea squid, the paucity of such available data has meant that growth estimation has to date been simply inferred from empirical field measurements collected from landed specimens. Estimates of growth rates for these squid have therefore been wholly based on size and age (via statolith) information obtained at isolated points in time. In this paper we use an individual-based model to explore the continuous growth trajectories that may be followed by deep sea squid through the course of their post-hatch life. Consistent with laboratory observations for growth of nearshore squid, the model incorporates an initial phase of exponential growth followed by linear growth after reaching a critical post-hatch age. Projections of size and age attainable are made for two scenarios which respectively, exclude and include energy budget constraints estimated from other cephalopods reared in captivity. The model is confronted with empirical data collected for different deep sea squid species and is used to investigate the lower and upper bounds attainable for both size and lifespan of the giant squid *Architeuthis dux*.

Effect of silver on maturation and development of the eggs of cuttlefish, *Sepia officinalis*

Thomas Lacoue-Labarthe[1], Paco Bustamante[1], Estelle Le Bihan[2], Noussithé Koueta[2].

[1] Laboratoire de Biologie et Environnements Marins, FRE-2727, Université La Rochelle, Avenue Michel Crépeau, 17042 La Rochelle, France, www.univ-lr.fr/labo/lbem, email: tlacouel@univ-lr.fr

[2] Laboratoire de Biologie et Biotechnologies Marines, UMR 100 IFREMER, Université de Caen Basse-Normandie, Esplanade de la Paix, 14032 Caen Cedex, www.unicaen.fr/ufr/ibfa/lbbm/accueil.htm, email: noussithe.koueta@unicaen.fr

The English Channel common cuttlefish, *Sepia officinalis,* makes large migrations inshore to mate and spawn in spring in shallow waters. Eggs are subject to chronic pollution by Ag in the Baie de Seine. The aim of this work is therefore to investigate the effect of contaminants on development of eggs in controlled conditions. Eggs were exposed to four low concentrations (0.1; 2; 100; 2000 ng/L) of waterborne Ag during the whole embryonic development. With this purpose, developmental parameters (egg weight, developmental stages, hatching rate) were evaluated. Physiological effects of Ag on the activities of the digestive enzymes cathepsin and acid phosphatases were also studied in whole eggs at different times of development. Concentrations of Ag in capsule, perivitelline fluid, vitellus and embryo were also determined. In the experimental conditions, exposure to the metal and the experimental rearing did not seem to disturb normal development of eggs according to studied parameters. Nevertheless, Ag seems to induce a dose-dependent effect on hatchling weight. Specific enzyme activities showed variations during the course of development. Lower activities and delay appeared with increasing Ag exposures. Data on bioconcentrations revealed a time window during which envelope permeability increased to Ag ions. Although low Ag exposure did not affect egg development, it disturbed embryo growth. Therefore, such Ag concentrations typically found in the Baie of Seine are likely to affect the survival of the newly hatched cuttlefish.

Localisation and characterization of digestive enzymes in cuttlefish *Sepia officinalis L.*

N. Koueta, A. Perrin, E. Le Bihan

Laboratoire de Biologie et Biotechnologies Marines, Université de Caen, 14032 Caen cedex, France.
email : noussithe.koueta@unicaen.fr

In order to study the effect of heavy metals on the digestive process, the digestive capacities of different parts of the digestive system of cuttlefish *Sepia officinalis* were analysed by biochemical methods. The total acid proteases, trypsin and cathepsin are mainly located in digestive gland while chymotrypsin is mainly located in posterior salivary gland. Acid phosphatase is highly distributed in the digestive gland, appendix of digestive gland and intestine. The characterization of acid phosphatase of the digestive gland showed this enzyme to have a molecular weight 141 kDa, optimal pH 4 optimal activity at 45°c, sodium fluoride, sodium molybdate and sodium tartrate acted as inhibitors, EDTA (EthyleneDiamineTetrAcetate) had no effect on this enzyme activity. The cathepsins E, D and B identified in digestive gland have respectively molecular weight of 110 kDa, 41 kDa and 22 kDa and optimal activity at pH 3 and 50°C. The enzyme stability was optimal at 5-35°C and pH 2 for cathepsin E and pH 4 for cathepsins B and D. The activity of cathepsins E and D was strongly inhibited by pepstatin and cathepsin B by TPCK (N-p-Tosyl-L-Phenylalanine Chloromethyl Ketone). EDTA activated cathepsin B activity. This investigation shows that acid phosphatase and cathepsin of the digestive gland can be used to study the impact of heavy metals on lysosomal activity of digestive gland cells.

Overview of metal physiology in cephalopods: general implications

P. Bustamante[1]

[1]Laboratoire de Biologie et Environnement Marins, Université La Rochelle,
Av. Michel Crépeau F-17042 La Rochelle, France, email: pbustama@univ-lr.fr

Cephalopods share a particular capacity to accumulate extremely high concentrations of essential and toxic metals. Cephalopods generally have short life-spans and therefore might reflect the environmental variations of oceanic metal concentrations. However, there are still many questions to address when studying the physiology of metal bioaccumulation and detoxification during their life cycle, mainly about the rates of the metal uptake and elimination, the role of organs in the detoxification and storage, and the molecules involved in the transfer processes within the organisms. Therefore, the goal of the present work is to give an overview of the processes that governs the bioaccumulation and detoxification mechanisms for some metals using relevant examples among essential and toxic elements, with special emphasis for Ag, Cd, Co and Zn, selected for their contrasted behaviour. Results concerning both field and experimental investigations showed that 1) the digestive gland is the main storage and detoxification organ for Ag and Cd, but Ag is mainly incorporated through the dissolved pathway (i.e. seawater) whereas Cd is mainly incorporated from food; 2) the turn-over of the metals greatly differs from one to another and differs during the life cycle according to the development of the storage tissue; 3) metal bioavailability is a key factor determining the rate of uptake 4) the detoxification in storage organs increasingly involves insoluble compounds when concentrations of the metals growth. In conclusion, the implications of metal physiology for using cephalopods as bioindicators of a given element is discussed as well as the implications for the transfer of metals to their predators.

Statolith and gladius aging of the southern arrow squid *(Nototodarus sloanii).*

Jean McKinnon[1], George Jackson[2]

[1]Department of Marine Science, University of Otago, P. O. Box 56, Dunedin, Otago 2001, New Zealand. Web address: www.otago.ac.nz/marinescience/, jean.mckinnon@stonebow.otago.ac.nz

[2]Institute of Antarctic and Southern Ocean Studies, University of Tasmania, Private Bag 77, Hobart, Tasmania 7001, Australia. www.scieng.utas.edu.au/iasos/ George.Jackson@utas.edu.au

A sample of squid were aged using their statoliths (n= 281, 139 male and 142 female). No squid was found to be older than 206 days. All squid had begun the maturation process by 91-120 days and all were mature at 180 days. There were different growth rate for male and female squid. Females tended to be longer and heavier than males of a similar age. Validation experiments were run on juvenile squid caught in a light trap (n=7). Calcein marks were visible in 5 of the statoliths but they were incomplete and indistinct and the periodicity of the growth rings could not be directly validated. A modal progression suggests that the periodicity of the increments is daily. Gladius increments were examined and measured for 36 individual squid and daily growth curves were reconstructed for these. Growth curves varied considerably between individuals and between males and females (with females having a shorter initial slow growth phase) indicating considerable individually plasticity in the form of growth.

Life cycle characteristics of the neon flying squid associated with oceanographic regime in the North Pacific

Taro Ichii[1], Kedarnath Mahapatra[2], Mitsuo Sakai[1], Denzo Inagake[3]

[1]National Research Institute of Far Seas Fisheries, 5-7-1 Orido, Shimizu-ward, Shizuoka 424-8633 Japan, email: ichii@affrc.go.jp

[2]Tokai University Frontier Ocean Research Center (T-FORCE), 3-20-1 Orido, Shimizu-ward, Shizuoka 424-8610 Japan

[3]National Research Institute of Fisheries Science, 2-12-4 Fukuura, Kanazawa-ward, Yokohama 236-8648 Japan

Seasonal recruitment, growth, and migration patterns of the neon flying squid *(Ommastrephes bartramii)* were examined in relation to oceanographic conditions in the North Pacific. *O. bartramii* undertakes an annual round-trip migration between subtropical spawning grounds and subarctic feeding grounds, which is comprised of an autumn and winter-spring spawning cohort. The autumn cohort grows faster during northward migration whereas the winter-spring cohort grows faster during southward return migration. Males and females of the autumn cohort follow separate migration patterns whereas those of the winter-spring cohort follow an almost identical pattern. We addressed the following three questions: (1) Why is there a difference in growth patterns between the cohorts? (2) Why is there a difference in migration patterns between the cohorts? (3) Why is there no summer cohort? These issues can be explained using seasonal meridional movements of the following three oceanographic zones: (a) unfavorable cold zone defined by sea surface temperature (SST) <10°C; (b) optimum spawning zone defined by the SST range: 21°C - 25°C; and (c) food-rich zone defined by position of Transition Zone Chlorophyll Front (TZCF). Lower stock size of the autumn cohort in the recent years (since 1999) can be attributed to the interannual variation in the TZCF position due to its possible impact on the productivity in the spawning ground.

Modelling intra-annual abundance variation of *Illex Argentinus* in the southwest Atlantic using generalised additive models

Chih-Shin Chen[1], Tai-Sheng Chiu[2]

[1]Institute of Fishery Biology, National Taiwan University, 1, Sec 4, Roosevelt Rd, Taipei 10617, Taiwan; email: ccshin.ntu.edu.tw

[2]Institute of Zoology, and Department of Life Science, National Taiwan University, 1, Sec 4, Roosevelt Rd, Taipei 10617, Taiwan

Illex argentinus is one of the most important marine resources that supports an international fishery with an annual average of 530 thousand tonnes caught during 1983-2003. Among these, Taiwanese jiggers accounted for ca. 30% of total production of squid. The production of *I. argentinus* reached its historical high peak in 1999, however, thereafter it showed a dramatic decline in the following years. Large annual variation in recruitment has been noted as characteristic of fisheries catches for short-lived species, such as squid. In this study, we applied generalised additive models (GAMs) in attempt to describe the intra-annual variation of *I. argentinus* in the southwest Atlantic using commercial jigger data. Models were constructed for years of "bad-catch" (1990, 1995, and 2002), and "good-catch" (1993, 1997, and 1999). The commercial catch per unit effort (CPUE) was standardised using a method of fishing power comparison and could represent the abundance index of squid. The models were built using cubic spline smoothers and Gaussian distribution with identity link. The effect of longitude was significant for all years in both "bad-catch" and "good-catch"groups. The variable of month was significant in all three years of the "bad-catch" group, and was significant in two years of the "good-catch" group. The effect of sea surface temperature (SST) was not significant in years of the "bad-catch" group, while a peak of abundance was noted in the SST range of 8-10°C in years of the "good-catch" group. The similar effect of longitude in the models for both years of "bad-catch" and "good-catch" could suggest a common pattern of spatial distribution of squid migration, which aggregate along the continental shelf break, while sparse onwards the shelf. The differences of effects in month and SST between years of "bad-catch" and "good-catch"was discussed.

Environmental influences on the recruitment of *Illex Argentinus* in the southwest Atlantic: I. The impact of onshore current on larval dispersal

C.H. Chang[1], G.P. Kirkwood[2], M.K. McAllister[2], L.V. Purchase[2], J.R. Beddington[2]

[1]Graduate Institute of Ecology and Environmental Education, National Hualien University of Education, 123 Hua-Hsi, Hualien 970, Taiwan ROC. email: cch@sparc2.nhlue.edu.tw

[2]Fisheries Group, Division of Biology, Faculty of Life Sciences, Imperial College, London, SW7 2BP, UK

One factor that might result in the annual recruitment fluctuations of *Illex argentinus* in the southwest Atlantic is the initial larval abundance transported to the nursery ground. A larval dispersal model, considering the ocean dynamics in the spawning area of *I. argentinus*, has been developed in this study for quantifying the variability of larval dispersal process. By assuming a normal distribution of squid spawning in May-July and a uniform distribution of larvae on the hypothesized hatching site off southern Brazil, the larval dispersal index (LDI) is developed to present the proportion of larvae that have been transported onshore to the nursery ground. This index was calculated based on the wind stress observed on the spawning and nursery ground in the period 1992-1998. The time series of LDI in 1992-1998 and the recruitment of *I. argentinus* in 1993-1999 have similar patterns (r=0.30) except for the high recruitment in 1999 which is likely to be due to the El Niño effect. The similarity between the LDI and squid recruitment suggests that larval dispersal is an important process in the early life and thus may affect the recruitment significantly.

Environmental influences on the spatio-temporal distribution and abundance of the southern Australian arrow squid, *Nototodarus gouldi.*

Kate E. Stark

IASOS & TAFI, University of Tasmania, Private Bag 77 Hobart Tasmania, 7001, kate.stark@utas.edu.au

N. gouldi are widespread in southern Australian shelf waters and are an increasingly important and valuable by-product of the South East Trawl Fishery (SETF) which encompasses much of their range. This study used catch-per-unit-effort (CPUE) data from the SETF (1985- 2004) to describe environmental influences on the distribution and abundance of *N. gouldi*. Spatial patterns were mapped using a GIS and then quantified with generalized additive models (GAMs), taking into account inter-annual variability in recruitment and seasonality of abundance. As the fishery does not target arrow squid, a two-stage GAM approach was used to incorporate zero catch data. Squid presence/absence was first modelled with a logistic model (binomial error distribution and logit link function), and secondly, non-zero observations of log transformed CPUE were modelled with a continuous Gaussian error distribution. The full set of covariates examined included spatial (latitude and longitude), temporal (year and month), fleet (vessel characteristics) and environmental (depth, sea surface temperature and sea surface colour) effects, along with all possible 2-way interactions. The predictive power of 'best' fit models which include environmental covariates was examined using intra-and inter-annual cross-validation, and the implications for management of the *N. gouldi* resource discussed.

How environmental factors affect the stock size of ommastrephid squids - a possible scenario

Yasunori Sakurai[1] , Sachi Miyanaga[1], Jun Yamamoto[2], Ken Mori[3]

[1]Graduate School of Fisheries Sciences, Hokkaido University, Hakodate, Hokkaido, 041-8611, Japan; e-mail: sakurai@fish.hokudai.ac.jp

[2]Hakodate Branch, Field Science Center for Northern Biosphere, Hokkaido University, Hakodate, Hokkaido, 041-8611, Japan; e-mail: yamaj@fish.hokudai.ac.jp

[3]Hokkaido National Fisheries Research Institute, Kushiro, 085-0802, Japan. E-mail: moriken@fra.affrc.go.jp

Recruitment success in squids depends largely on environmental conditions at the spawning and nursery grounds. The ommastrephid squids are commercially important, however their annual catches fluctuate widely. They produce gelatinous, nearly neutrally buoyant egg masses that contain many small eggs. The egg masses are thought to occur within or above the pycnocline at temperatures suitable for egg development (e.g., 15-23˚C in *T. pacificus*) and under conditions of reduced predation. After hatching, the paralarvae presumably ascend to the surface layer and are advected into convergent frontal zones. We observed something resembling a *T. pacificus* egg mass within the pycnocline at 70-120 m depth (temperature range: 18-21˚C) in the Tsushima Current using an ROV. We also estimated from laboratory studies that hatchlings ascend to the surface at temperatures of 18-23˚C. Results of a previous study (by YS) suggested that annual catches of *T. pacificus* increased during periods of weak winds and warm air temperature, suggesting that the strength of winter winds may affect recruitment. We will present a scenario for how stock size in ommastrephid squids might fluctuate due to environmental factors such as the winter wind stress, air temperature at the sea surface, and mixed layer depth at the spawning grounds.

The giant Pacific octopus *(Enteroctopus dofleini)* in Prince William Sound, Alaska - adaptive foraging, population trends, and climate change.

D. Scheel, T.L.S. Vincent

Alaska Pacific University, 4101 University Dr. Anchorage, AK 99508. http://marine.alaskapacific.edu/, email: dscheel@alaskapacific.edu

The habitat ecology of the giant Pacific octopus *(Enteroctopus dofleini)* in Prince William Sound, Alaska, was examined over the period 1995-1998 and 2002-2005. Availability of live *Cancer oregonensis, Pugettia gracilis* and *C. productus* (Decapoda, Brachyura) increased during the study; but changes in midden content differed in extent or direction from prey trends. Larger prey have greater energy content, and octopuses selected larger individuals, increasingly so over the study (even as average prey size declined), resulting in greater foraging success in latter years. These results (selectivity by prey type and size) indicate octopus may be adaptive foragers exhibiting rate-maximizing prey-choice. Octopus population trends did not track prey population trends: octopus densities increased (1995-1998) and then declined (2000-2004), while prey increased throughout the study. An unusually warm summer and fall in 2004 was followed in 2005 by the highest recruitment of individuals 1.4-100 g recorded during this 11-year study. Thus, while new techniques to study octopus behavior may improve understanding of octopus-resource relationships, study of recruitment processes will also be required to understand local population dynamics.

Distribution and growth of the common squid paralarvae in the Ria of Vigo (NW Spain)

A.F. González[1], J. Otero[1], A. Guerra[1]

[1]Ecobiomar, Instituto de Investigaciones Marinas (CSIC). Eduardo Cabello 6, 36208 Vigo, Spain, www.iim.csic.es, email: afg@iim.csic.es

A scientific research program targeting the early life stages of *Loligo vulgaris* was undertaken in the Ria of Vigo (NW Spain) during 2003 and 2004. A total of 30 cruises, including two with 24h sampling, were undertaken. Each cruise included biological and oceanographic sampling. Zooplankton samples were collected by towing a bongo net in two different strata: surface and near bottom waters. The abundance of paralarvae during daylight was consistently higher in the bottom stratum. On the other hand, the maximum abundance (Ind/1000 m^3) of paralarvae during the night was remarkably higher (45) than during daylight (7). The wet weight and eight other measurements were recorded for all paralarvae. The eye diameter showed a high correlation with the length (0.83) and age (0.78) of the individuals. The statoliths of 202 paralarvae were studied. The ageing data confirmed that hatching occurred throughout the year with two peaks of abundance in summer and autumn. The paralarvae remained in the water column in the proximities of the coast for up to 70 days.

Relationship between RNA/DNA ratio and growth in reared squid paralarvae during starvation and refeeding

Erica Vidal

University of Rio Grande – FURG, Department of Oceanography, CX. P. 474
Rio Grande RS 96.201.900, Brazil. email: ericavidal2000@yahoo.com.br

The RNA/DNA ratio, specific growth rate (SGR) and survival of *Loligo opalescens* paralarvae exposed to starvation and refeeding was measured. The RNA and DNA of each paralarvae were extracted using the ethidium bromide fluorometric technique. Fourteen days old paralarvae were separated into five feeding treatments: a control treatment (food was always available) and treatments starved for 2, 3, 4 and 5 days, and then refed. Paralarvae did not survive 4 and 5 days of starvation, showing that at 15 days of age and at 16°C the limit to recovery is 3 days of starvation. The resulting equation between RNA/DNA ratio and SGR of paralarvae was SGR= 1.74 RNA/DNA –11.79. Growth rates ranged from –14 to 21 % d^{-1} and the RNA/DNA ratio explained from 50 to 81% of the variability observed in growth rate. After starvation, there was a reduction in growth variability in all starved treatments, while variability remained high in the control treatment. Evidences from this study suggest that in the presence of food growth variability would tend to increase, allowing the survival of individuals with a wide range of growth rates, but under starvation conditions, variability would be reduced through the selection of the stronger and faster growing squid.

The role of initial hatchling size and temperature on the growth of captive pale octopus *(Octopus pallidus).*

S.C. Leporati, J.M. Semmens, G.T. Pecl.

Marine Research Laboratories, Tasmanian Aquaculture Fisheries Institute, University of Tasmania, Private Bay 49 Hobart Tasmanian 7001, Australia.
email: scl0@utas.edu.au

This study investigated the roles of initial hatchling size and simulated natural seasonal temperature regimes on the growth of individual pale octopus (*Octopus pallidus*). A total of 64 octopus hatchlings were reared in captivity for 90 days. The octopuses were held in individual enclosures with initial hatchling weight recorded, and daily food consumption and fortnightly growth monitored. Two temperature treatments were applied replication local seasonal water temperatures; increasing spring/summer temperatures (14–18ºC, T1) and decreasing summer autumn temperatures (18–14ºC, T2), with temperatures altered 1ºC every 18 days. Octopus in the T2 temperature regime grew significantly faster than those in the T1 treatment, probably due to the higher initial temperature. However, growth patterns did not change dramatically as the temperatures in T1 increased and decreased in T2, highlighting the crucial importance of initial conditions on subsequent growth. Interestingly, initial hatchling size played an important role in growth for octopus reared under the decreasing temperature regime (T2) with smaller hatchlings growing faster than larger hatchlings, but this effect was not evident in the increasing temperature regime (T1). Initial hatchling size may play a role in subsequent growth; however, this is secondary to temperature effects.

Comparative study of the embryonic development of the Japanese ocellate octopus *Octopus ocellatus* (Gray, 1849) and *Octopus vulgaris*

Hashimoto Hashimoto[1], Tsuchiya Koutaro[2], Segawa Susumu[2]

[1]Laboratory of Invertebrate Zoologyminatoku, University of Marine Science and Technology, Kounan 4-5-7 Tokyo 108-8477 Japan, email: hassyon@hotmail.com

[2]Tokyo University of Marine Science & Technology, Konan, Minato, Tokyo 108-8477 Japan,
email: kotaro@s.kaiyodai.ac.jp, segawa@s.kaiyodai.ac.jp

In octopus there are two types of hatchlings, namely, pelagic and crawling types. The Japanese ocellate octopus *Octopus ocellatus* Gray, 1849 living in the coastal waters of Japan produces the crawling type of hatchlings with relatively large-sized (7.54-8.53×3.07-3.34m) and fewer numbers of eggs laid in a cluster. In general, the eggs producing crawling larva are larger in size and fewer in number compared with those of pelagic larva, such as *Octopus vulgaris.* In the present study we investigated the morphology of *O. ocellatus* in early ontogeny associated with ecological adaptation. Furthermore, the present study aims to discuss the morphological differences in embryonic development between species that produce the crawling and pelagic *(O. vulgaris)* larvae. Chronology of appearance of the anlagen eyes, funnel, gill, olfactory organs and chromatophores are systematically similar between the two species. However, development of suckers differs between the species; it occurs earlier in *O. ocellatus* than in *O. vulgaris.* The differentiation of suckers in *O. ocellatus* occurs continuously until hatching, resulting in larger numbers of suckers compared to *O. vulgaris* hatchlings (3-4). Morphological functions of suckers and chromatophores seem to be important for survival of post-hatching larvae. Differences in their developmental process are discussed in relation to the adaptations in early life history of each species.

Optimising a closed system for culturing New Zealand broad squid, *Sepioteuthis australis*

Jason Tutara

Earth and Oceanic Sciences Research Institute, Auckland University of Technology, Private Bag 92006 Auckland 1020, New Zealand. jtutara@aut.ac.nz

Commercial-scale squid aquaculture has only recently become viable, as understanding of the food and habitat requirements of myopsid squid has advanced. The genus *Sepioteuthis,* specifically *S. lessoniana,* has been cultured most successfully; however, comparable success has seldom been achieved for other species, even the closely related south Pacific species *S. australis.* Mortality in squid culture is highest during the earliest developmental stages, both within the egg capsule and through to five days age as a paralarva. The following have proven critical for effective culture of *S. australis:* sufficient aeration and circulation in tanks accommodating eggs; immediate separation of hatched paralarvae from egg mass; appropriate tank size, shape and circulation; and most importantly, sufficient numbers of appropriate-sized, non-aggressive live prey. Investigations into optimal tank configuration and diet for successful culture of *S. australis* are herein reported, for the intended purpose of enhancing techniques for commercial, albeit niche-market culture of this species.

Temporal changes in the inferred areas of optimal survival of Japanese common squid *(Todarodes pacificus)* paralarvae caused by winter cooling on the spawning grounds

Jun Yamamoto[1], Yasunori Sakurai[2]

[1] Field Science Center for Northern Biosphere, Hokkaido University, Hakodate 041-8611, Japan. email: yamaj@fish.hokudai.ac.jp

[2] Graduate School of Fisheries Sciences, Hokkaido University, Hakodate 041-8611, Japan

Todarodes pacificus, commercially the most important squid in Japan, forms two main populations with different spawning peaks (autumn and winter). Both populations spawn mostly in the East China Sea, and hatchlings are transported northward by the Tsushima Warm Current (TWC) to the Sea of Japan and by the Kuroshio to the northwest Pacific. Consequently, *T. pacificus* paralarvae are spread over a large area with widely differing conditions for survival. This study identified the optimal area for survival (OAS) from November to March in the East China Sea based on observations from previous studies (i.e., the optimal temperature for hatching is 19-23˚C, hatchlings occur near surface, and hatchlings occur inshore of the Kuroshio) and examined temporal and spatial changes of the OAS using satellite images. The OAS was found to shift south due to cooling by the winter monsoon from the TWC to the Kuroshio. We conclude that the differences in spawning grounds and transportation routes between the two populations are due to winter cooling on the spawning grounds.

Postembryonic development of the adhesive organ in *Idiosepius* under artificial conditions

Janek von Byern[a], Shuichi Shigeno[b], Waltraud Klepal[a], T. Kasugai[c]

[a]University of Vienna, Cell Imaging and Ultrastructure Research, Vienna, Austria, vByern@freenet.de & Waltraud.Klepal@univie.ac.at;

[b]RIKEN, Center for Developmental Biology, Evolutionary Morphology Group, Kobe, Japan, shigeno@cdb.riken.go.jp

[c]Port of Nagoya Public Aquarium, Nagoya, Japan t-kasugai@nagoyaminato.or.jp

The pygmy squids *Idiosepius* comprise the smallest species within the cephalopods; mature males have a mantle length of less than 1 cm *(Idiosepius biserialis)*. An earlier study by Yamamoto (1988) on *Idiosepius paradoxus* showed that the adhesive organ was visible 9 days after oviposition, but the development in early ontogeny is still poorly understand. Further cultivation of hatchlings in aquaria has been limited to 4-6 days because of unsuitable food sources. Therefore, no data are available about the postembryonic life, onset of sexual maturity and behaviour of this genus. For the first time, 3 embryos of *Idiosepius paradoxus* were cultivated over 19 days after hatch and one hatchling reached the age of 26 days. Hatchlings were cultivated in aquaria from spawn, collected May 1999 at Nagoya (34° 35.567´N, 134° 07.340´E) by T. Kasugai from Port of Nagoya Public Aquarium. The hatchlings successfully attacked, caught, and fed on slowly swimming nauplii of mysids. Fourteen days after hatch, the juveniles first showed an adhesive behaviour and ejected ink when threatened. Between day 19 and 26 the animals grew from 2 - 2.5 mm (mantle length at 20-24 °C). These observations indicate that pygmy squids inhabit sea grass and algae early after hatch.

Upper-beak growth increments in ommastrephid paralarvae

Mitsuo Sakai[1], Norma E. Brunetti[2], John Bower[3], Beatriz Elena[2], Tsuneo Goto[4], Taro Ichii[4], Marcela Ivanovic[2], Yasunori Sakurai[3], Toshie Wakabayashi[3], Akihito Yatsu[5]

[1]National Research Institute of Far Seas Fisheries email: sakaimit@affrc.go.jp

[2]Institute Nacional de Investigacion y Desarrollo Pesquero

[3]Hokkaido University

[4]Japan Sea National Fisheries Research Institute

[5]National Research Institute of Fisheries Science

Growth increments in the beaks of paralarvae from five ommastrephid squids (*Dosidicus gigas, Illex argentinus, Ommastrephes bartramii, Sthenoteuthis oualaniensis* and *Todarodes pacificus*) were examined to determine if the increments form daily. Paralarvae were obtained through both artificial fertilization and field collections, and increments in the lateral wall of the upper beak were examined under a light microscope. In artificially reared paralarvae, increments formed daily in all individuals except for several *S. oualaniensis*, and increments began to form on the first day (*O. bartramii* and *D. gigas*) or second day (*I. argentinus* and *T. pacificus*) after hatching. In field-caught paralarvae, the numbers of beak increments and statolith increments (which have been shown to form daily in several ommastrephids) were significantly correlated through about the first 50 days after hatching in *I. argentinus* and through the first 15 days after hatching in *O. bartramii*. Beak-increment analysis will be a useful technique for ageing specimens whose statoliths have dissolved during preservation in formalin or isopropanol solution.

New method of direct stock assessment of the loliginid squid

M.R Lipinski[1], M. Soule[2]

[1]Marine and Coastal Management, DEAT, Private Bag X2, Roggebaai 8012 Cape Town, South Africa, www.mcm-deat.gov.za, email: lipinski@deat.gov.za;

[2]Fisheries Resource Surveys, P.O. Box 31306, Tokai 7966 Cape Town, South Africa, email: frs@new.co.za.

Hydroacoustic research on chokka squid, conducted 1994 – 2004, has led to the development of new direct stock assessment methods, possibly applicable to all loliginids which concentrate inshore to spawn. This method relies on the hydroacoustic biomass estimate of all inshore concentrations, detected and mapped by fishermen at the time of the survey. The stability of these concentrations is assessed in tag-and-recapture experiments, the methodology of which is already published, and additionally by the demersal survey. The latter allows the estimate of the minimum biomass of squid dispersed between concentrations inshore. It is assumed that in the loliginid squid over its distribution range, concentration biomass and dispersion biomass are inversely proportional, and maturity and degree of concentration – directly proportional. With this in mind, minimum dispersion biomass offshore is estimated on the basis of the separate demersal survey, and concentration biomass offshore on the basis of maturity index and proportionality equation. All components are then summed up. This biomass is the minimum snapshot, which has complex dynamics in time, as new squid quickly recruit to the adult pool. This dynamics is of critical importance, if the method is to be used as a tool in the squid fisheries management. Larvae and juveniles are not estimated at all. These shortcomings are being addressed in new planned research.

A Bayesian Delury model for the stock assessment of *Loligo gahi* from Falkland Islands waters.

P.A. Orr[1], C.G.J. Michielsens[2], D.J. Agnew[1]

[1]Renewable Resources Assessment Group, Imperial College, Prince Consort Rd., London, SW7 2BP, UK. p.orr@imperial.ac.uk, d.agnew@imperial.ac.uk

[2] Finnish Game and Fisheries Research Institute, P.O. Box 2, FIN-00791, Helsinki, Finland. catherine.michielsens@rktl.fi

The Falkland Island *Loligo gahi* fishery has been managed since 1987. During the limited fishing season, stock assessments are routinely conducted in real-time using a Delury depletion model with the aim of conserving a spawning biomass of at least 10,000-20,000 tonnes. While this method has worked well in the past, in recent years it has become increasingly difficult to identify a decline in CPUE during a season (a pre-requisite for the Delury assessment model). In such cases, *ad hoc* or "inverse-q" assessments are carried out using historic catchability estimates to convert current season CPUE data into estimates of stock abundance. This approach is analogous to the use of prior information by Bayesian models and consequently has led to the development of a Delury model within a Bayesian hierarchical framework using the software WinBUGS. In contrast to "inverse-q" assessments, the new Bayesian model formally accounts for uncertainty in the distribution of prior information and provides robust early estimates of stock size using CPUE and weight information within a few weeks of the opening of the fishery – an obvious advantage when the goal of management is to prevent numbers of the exploited spawning stock from declining below a critical escapement biomass.

A multi-indicator system for the assessment and management of the short-fin squid *Illex coindetii* (Verany 1839) stock in the southern Adriatic Sea (Central Mediterranean)

Luca Ceriola[1], Nicola Ungaro[2], Francesco Toteda[1]

[1]Department of Animal Production, University of Bari – Italy, Via Orabona 4, Bari Italy 70125, email: midamail@tin.it

[2]Laboratory of Marine Biology of Bari - Italy

The defining of a multi-indicator system to evaluate the exploitation level of the short-fin squid *Illex coindetii* (Verany 1839) stock in the southern Adriatic Sea (Central Mediterranean), was approached using fishery independent data (data from experimental bottom trawl surveys, "Medits" programme, years 1996-2004). The trajectories of nine population indicators, occurrence, abundance, density, recruitment index, spawner index, mean body weight, mean body length, mean body length excluding the recruits, mean body length-length at maturity ratio, were analysed utilising statistical estimators such as arithmetic and geometric mean, median, and 75th percentile. In the study period an increase of the resource in terms of occurrence, abundance and density was coupled with some changes in the population structure: decrease in the mean weight and mean length, and increase in the recruits. The observed condition may be linked to the capability of *I. coindetii* to respond quickly to the "environmental" or "ecosystem" changes (i.e. the increase in sea temperature and/or modifications in the trophic net) and to the fishery exploitation. Accordingly with the results the multi-indicator system approach is illustrated as a means of following dynamic changes within the *I. coindetii* stock, and providing useful information for the management of the resource.

The English Channel stock of *Sepia officinalis:* Can biomass dynamic models and survey indices help to understand the increase in landings?

Beatriz Roel[1], Georg H. Engelhard[1], Juliette Royer[2], Véronique Legrand[3], Franck Coppin[4], Jean-Paul Robin[2]

[1]CEFAS, The Centre for Environment, Fisheries and Aquaculture Science, Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk NR33 0HT, UK, email: B.A.Roel@cefas.co.uk

[2]Laboratoire de Biologie et Biotechnologies marines, Institut de Biologie et Biochimie appliquée, Université de Caen, esplanade de la Paix, 14032 Caen Cedex, France, email: jean-paul.robin@unicaen.fr

[3]Comité Régional des Pêches Maritimes et des Elevages Marins, 9 quaai du general Lawton Collins, B.P. 445, 50104 Cherbourg cedex, France email: vlegrand.crpbn@wanadoo.fr

[4]Laboratoire ressources halieutiques, Centre IFREMER de Boulogne sur mer, 150, quai Gambetta - BP 699, 62321 Boulogne-sur-Mer, France. email:Franck.Coppin@ifremer.fr

Since 1997 cuttlefish has been the most important cephalopod group taken in European Atlantic waters and more than half of cuttlefish landings concern the English Channel *Sepia officinalis* stock. Increasing cuttlefish landings in this area can either come from higher stock size and/or higher fishing effort. However, effort is difficult to estimate because cuttlefish can be target or by catch species according to the fishing fleet and the fishing season. A biomass-based dynamic model was fitted to analyse stock trends in the period 1992-2004 to better understand stock trends. This model uses commercial fishery statistics from the UK and France and trawl abundance indices collected during CEFAS and IFREMER surveys. The slight increase in average biomass suggests that there is general increasing trend in exploitation rate, which can be concealed by environment driven recruitment variability. Results are discussed in the light of previous assessment exercises carried out on this stock (Dunn, 1999; Royer, 2002) and of management issues raised by fishermen.

Population structure in the giant Australian cuttlefish: Combining information from molecular, morphometric and chemical approaches.

Melita de Vries[1], Bronwyn Gillanders[1], Steve Donnellan[2], Leanne Wheaton[1]

[1]School of Earth and Environmental Sciences, Darling Building DP418, University of Adelaide, SA 5005, Australia. http://www.marinebiology.adelaide.edu.au/; email: Melita.devries@adelaide.edu.au, Bronwyn.gillanders@adelaide.edu.au, Leanne.wheaton@adelaide.edu.au

[2]South Australian Museum, North Terrace, Adelaide, SA 5000, Australia. http://www.samuseum.sa.gov.au/; Donnellan.Steve@saugov.sa.gov.au

An understanding of the stock structure of a species is necessary for identifying the appropriate strategy for managing the species. Using a combination of morphometric, molecular and chemical techniques, the aim of this project was to determine the geographic extent of stocks of *Sepia apama* (giant Australian cuttlefish) in South Australian waters. The best approach to determine population structure is to use a combination of complementary methods that address different aspects of the biology of the species. To assess morphometric variation among sites a total of 34 morphometric body and sepion measurements were taken from samples and analysed after log-transformation with principal components analysis and stepwise discriminant function analysis. Molecular genetic techniques involved the comparison of microsatellite allele frequencies among locations across years to determine the spatial and temporal partitioning of variation in allele frequencies among samples. Statoliths were removed and analysed for concentrations of barium, magnesium and strontium using laser ablation inductively coupled plasma-mass spectrometry (LA ICP-MS) to determine differences among locations. The results from this study will be used to determine appropriate management strategies for *S. apama*.

The diversity of cephalopods in commercial fisheries of New South Wales, Australia

Jonathan D. Nottage[1],[2], Steven S. Montgomery[3], Ron J. West[1], Ken Graham[3]

[1]Earth & Environmental Science, University of Wollongong, NSW 2522, Australia, email: nottagej@hotmail.com

[2]Current address: PO Box 618, Newport, OR 97365, USA.

[3]Cronulla Fisheries Research Centre, PO Box 21, Cronulla, NSW 2230, Australia.

This paper presents results of the first study to quantitatively document cephalopod diversity in commercial fisheries landings of New South Wales, Australia. A total of 21 cephalopod taxa were observed in randomly selected samples from the three major regions of landings. *Sepia hedleyi* and *S. rozella* comprised the greatest proportion of taxa present in cuttlefish samples. *Octopus australis* and *O. tetricus* were most often encountered in octopus samples, while *Sepioteuthis australis* and *Nototodarus gouldi* comprised the greatest proportion of squid samples. Multivariate analyses identified significant differences in the proportions of taxa present between seasons, as *S. apama* and *Loliolos noctiluca* were observed only in spring, and *S. whitleyana, Todaropsis eblanae* and *O. maorum* only in winter. Taxa such as *S. hedleyi* and *O. australis* exhibited spatial patterns in landings. Cephalopod diversity in the present study was generally consistent with that observed in previous years during fishery independent surveys of prawn trawl grounds. Quantifying cephalopod diversity in New South Wales commercial fisheries provides the necessary first step toward the sustainable management of these valuable resources.

Fisheries biology of northern Australian squid.

Malcolm Dunning, Len Olyott, Kate Yeomans, Scott McKinnon

Department of Primary Industries and Fisheries, Queensland, GPO Box 46, Brisbane, Qld, 4001, Australia, http://www.dpi.qld.gov.au/fishweb/, malcolm.dunning@dpi.qld.gov.au

Squid are an increasing component in the reported byproduct of commercial prawn and finfish trawlers in northern Australian shelf waters and interest has been shown by Queensland and Northern Territory fishers in developing target fisheries for squid using jigs. In general, squid caught on jigs or in lift or other surround nets are of higher quality, larger size and, on overseas markets, fetch a much higher price than squid caught by trawling. This project aimed to consolidate and enhance knowledge of the fisheries biology of inshore squid in northern Australian waters. Squid byproduct from commercial trawl and research catches off the Queensland east coast, the Gulf of Carpentaria and the Kimberleys (limited samples) revealed that although different species favoured particular habitats or depth zones, catches in many areas consisted of more than one squid species. Slender (*Photololigo* sp. 4) and broad (*Photololigo etheridgei*) squid reach 40 cm ML (500g) and 20 cm ML (160g) respectively. Length at reproductive maturity was also highly variable. Mature females were present in most months of the year in areas sampled regularly (Moreton Bay - broad squid and off Bundaberg - slender squid). Although no comprehensive surveys could be undertaken in inshore waters, potential spawning grounds of northern calamari (*Sepioteuthis lessoniana*) were identified off southern and central Queensland from interviews with fishers. Slender squid spawning grounds were identified only in the western Gulf of Carpentaria and off the Kimberleys. No major spawning grounds for broad squid were identified in Moreton Bay or inshore waters elsewhere despite historically intense commercial and research trawling.

Management of the southern squid jig fishery

Phil Domaschenz, Yvonne Zunic

Australian Fisheries Management Authority, John Curtin Building, 22 Brisbane Ave, Barton, ACT 2610, phil.domaschenz@afma.gov.au

The southern squid jig fishery operates in Commonwealth managed waters adjacent to NSW, Victoria, South Australia and south eastern Queensland. The majority of fishing effort has occurred in the waters off western Victoria near Queenscliff and Portland. The 2003-04 catch was 2,314 tonne valued at $1.889 million. During 2005 some 80 fishing permits were granted to operators but of these only 14 were actively fished. The Australian Fisheries Management Authority (AFMA) management philosophy includes a partnership approach to the management of marine resources. To foster this partnership AFMA has formed research and management advisory committees with membership representing industry, management, scientific and environmental interests.

Assessing the feasibility of using 'by-catch' data as a pre-recruit index in South Australia's southern calamary *(Sepioteuthis australis)* fishery.

Mike Steer

South Australian Research and Development Institute – Aquatic Sciences PO Box 120,
Henley Beach, South Australia 5022.
email: steer.michael@saugov.sa.gov.au

Trends in spatial and temporal commercial catch, effort and estimates of catch per unit of fishing effort (CPUE) data are currently the only indicators of stock biomass for the South Australian southern calamary (*Sepioteuthis australis*) fishery. Time delays associated with collating and analysing these data combined with the squid's sub-annual lifespan means that there is no warning of recruitment failure. Consequently, there is a need for reliable pre-recruit indices, or biological performance indicators, that would allow managers to track the status of the fishery to respond quickly to negative indicators in 'real-time'. South Australia is in a unique position as juvenile and sub-adult calamary are incidentally caught in the offshore prawn-trawl fishery from November to July, excluding January and February, allowing access to an important pre-recruit life history stage. Structured fishery-independent trawl surveys are regularly carried out to assess the status of South Australia's Western King prawn (*Melicertus latisulcatus*) population in State waters providing an opportunity to simultaneously quantify calamary 'by-catch' over space and time. The scope of this research is, therefore, to assess whether relevant links exist between the abundance of pre-recruits caught in the offshore trawl fishery and commercial catch statistics obtained from the inshore calamary fishery.

Co-operative development of area-based management of southern calamari

Matt Bradshaw

Department of Primary Industries, Water and Environment, GPO Box 44, TAS, 7001,
Matt.Bradshaw@dpiwe.tas.gov.au.

Being able to prove that a fishery is being exploited sustainably places a considerable onus on science regarding the provision of evidence. Management as an outcome of a collective and negotiated process involving 'managers', industry and scientists relies on information from both fishers and researchers. Research understanding of the species biology and behavioural characteristics of southern calamari in Tasmania played a significant part in development of efficacious management arrangements which are an example of co-operation between the three principal stakeholder groups. Research was undertaken with assistance from industry, and both groups contributed to the design of a spatial and temporal closure as part of the sustainable management of the species.

An ecological study of nautilus on Osprey Reef

Andrew Dunstan

1Undersea Explorer, P.O Box 615, Port Douglas, Qld, Australia, 4871.
www.undersea.com.au, info@undersea.com.au

Little is known about nautilus wild growth rates and population size; key criteria required to sustainably manage nautilus fisheries.This study provides this data for a population of *N. pompilius* at Osprey Reef in the Coral Sea, Australia. Osprey Reef is a seamount, 195 square kilometres in area, in the Coral Sea (13 53 47S, 146 33 24E), with steep coral walls dropping to over 1000m. The Osprey Entrance site is the major trapping location, while other sites around the entire perimeter of Osprey Reef were also sampled. Overnight trapping was conducted at depths of 50 to 400 metres. Captured nautilus were described, photographed, measured and tagged before release. Over 200 recaptured individuals enabled the population size of nautilus at Osprey Reef to be estimated at approximately 6000 individuals and growth rates were estimated to be approximately 0.4mm / week. This data in conjunction with a reported life span of 20 years, late maturity and low fecundity describe an animal vulnerable to easy overexploitation and rapid population decline. Nautiluses are fished for the ornamental shell trade in a number of locations where populations have already crashed. This study provides important data to aid in future sustainable management of nautilus fisheries.

Key behavioral attributes of squid and cuttlefish spawning aggregations that warrant consideration for conservation and fisheries management.

Roger T. Hanlon[1]

[1]Marine Biological Laboratory, Marine Resources Center, 7 MBL Street, Woods Hole,
MA 02543 USA, http://www.mbl.edu/mrc/hanlon/index.html, rhanlon@mbl.edu

Several fisheries for *Loligo* and one for *Sepia apama* are based partly or mostly on their nearshore aggregation to lay eggs. However, egg laying is the culmination of an intricate set of sexual behaviors whose multifaceted sequences and their spatial and temporal variations are key to successful gene flow and vigor in the population. I will review and analyze recent data on aspects of mate choice, pair formation and maintenance, mate guarding, sperm competition, sperm storage, cryptic female choice, male sneaker tactics, sexual mimicry, rate of egg deposition and multiple paternity as they pertain to mating system flexibility and life history strategies. Attention will be drawn to the potential ways in which fishing practices (i.e., purse seining, trawling, jigging) can interfere with (a) these complex sexual selection processes, (b) rates of egg deposition and (c) intermittent spawning behavior of individual females. Spawning habitat and the variations in concentrated versus distributed egg beds will be considered, as will the possibility that *Loligo pealeii* may home back to natal spawning grounds. Some possible solutions (including new acoustic and video methodology) for studying and monitoring these critical behavioral processes will be presented.

Assessing the validity of stylets as ageing tools on *Octopus pallidus*

Zoë Doubleday[1],[2], Jayson Semmens[2], Gretta Pecl[2], George Jackson[1]

[1 a] Institute of Antarctic and Southern Ocean Studies, University of Tasmania, Private Bag 77, Tasmania, Australia 7001, zoeanned@utas.edu.au,

[1] Tasmania Aquaculture and Fisheries Institute, University of Tasmania, Private Bag 49, Tasmania, Australia 7001,

A method to age octopus was determined through the quantification of growth increments within the stylet structure (a highly reduced internal shell). To validate the periodicity of the increments, stylet increments were analysed from known-age laboratory-raised *Octopus pallidus.* The animals, which ranged from three to eight months old, were exposed to either a simulated natural or constant temperature regime. Transverse stylet sections were embedded in thermo-plastic cement and ground until a thin section was achieved. A pre-hatch region and first post-hatch increment was identified in the stylet microstructure. The number of increments, across all ages and temperature treatments, was in remarkably close agreement to age (number of days), clearly demonstrating that stylet increments are deposited daily throughout the lifecycle of *O. pallidus.* Morphometric analyses of the stylet indicated that increments were laid down regularly during stylet growth and that stylets grew in concert with body size, further supporting daily periodicity. This is the first study to successfully validate daily increments in stylets and thus demonstrate a method to age octopus. This study will have critical implications for future octopus research and the effective management of stocks worldwide.

Variability in cephalopod and pelagophil fish reproductive strategies in respect to the species diversity

Vladimir Laptikhovsky

Falkland Islands Government, Fisheries Department, FIPASS, Stanley, FIQQ 1ZZ, Falkland Islands
email: vlaptikhovsky@fisheries.gov.fk

The Atlantic Ocean is younger and its fauna is poorer than that of the Indo-Pacific. To determine if there was a link between species diversity of these water masses and the spectra of reproductive strategies employed by marine organisms, the egg size of cephalopods and 121 species of pelagophil fish were compared. The mean size of both Octopodidae and pelagophil fish eggs from the Atlantic was larger than those from the Indo-Pacific. In both these regions, octopods typically had either a small- or large-egg strategy. Bimodal egg size distribution was particular for clupeid and all pelagophil fish also, demonstrating that only extreme r- and K-strategies sensu Pianka (1970) are evolutionary stable (Vance, 1973). An increase in egg size at lower species diversity is consistent with Alekseev's (1981) hypothesis proposed earlier to explain Thorson's rule, which states that the fitness of an egg becomes more important for survival when there is a decrease of predator diversity and a simplification of the ecosystem structure. This is because there is an increase in the competition for food, and mortality factors for early life stages are less chaotic, so species begin to invest more energy into individual egg.

Fecundity and reproductive strategies of deep-sea incirrate octopuses

Iain Barratt, Louise Allcock, Mark Johnson

Queens University Belfast, Medical Biology Centre, Belfast Northern Ireland BT9 7BL,
97 Lisburn Road, United Kingdom, ibarratt01@qub.ac.uk

Reproduction and fecundity were investigated in nine species of deep sea octopuses: *Bathypolypus arcticus, Bathypolypus bairdii, Bathypolypus ergasticus, Bathypolypus sponsalis, Bathypolypus valdivae, Benthoctopus levis, Benthoctopus normani, Benthoctopus* sp. and *Graneledone verrucosa* (total n = 85). The ovaries of preserved specimens were removed and weighed; oviducal glands and oviducts were measured. Fecundity was estimated from egg counts and eggs were measured. Differences in ovulation pattern at maturity may indicate differences in spawning pattern and reproductive strategy and this was investigated using size frequency histograms and multivariate analysis. Group synchronous development of eggs in one species of deep-sea octopus suggests a simultaneous terminal spawning strategy. In contrast, asynchronous ovulation in two other deep-sea species suggests a continuous spawning strategy.

The protection of future breeding stocks – modelling spawning areas of the squid *Loligo forbesi.*

G.J. Pierce[1], C.D. MacLeod, G. Stowasser[1], T. Valinassab, M.B. Santos, J. Wang, I. Tuck.

[1]University of Aberdeen, School of Biological Sciences, Tillydrone Avenue, Aberdeen AB24 2TZ, UK, email: g.j.pierce@abdn.ac.uk

The fishery of *Loligo forbesi* in UK waters is largely unregulated and little is known about how this fishery affects breeding success. As a short-lived, semelparous species, the existence of future generations of *L. forbesi* is likely to be heavily dependent upon the ability of the present generation to successfully spawn and produce viable offspring. Therefore, disturbance of *L. forbesi* in spawning areas has the potential to have a substantial impact on viability of the species. However, little information exists at present about the location of spawning areas. The existence of specific spawning areas or habitats can be inferred by examining the distribution of sexually mature animals within the environment. In this study, we used research cruise data collected in 2004-05 and historical records collected during fisheries research cruises (1980-present), to map the distribution of mature squid in UK waters, to determine the location of spawning areas and examine habitat characteristics (e.g. depth, substrate, temperature) of putative spawning areas. The results of this study suggest, that both the percentage of gravel in the sediment and the standard deviation of the slope are important factors influencing the abundance of mature *L. forbesi*. Abundances were furthermore significantly related to water depth and sea surface temperature.

The daily spawning cycle of *Loligo vulgaris reynaudii*

Warwick Sauer, Y. Melo

Rhodes University DIFS, P.O. Box 94, Rhodes University, Grahamstown Eastern Cape 6140 South Africa. w.sauer@ru.ac.za

The daily spawning cycle and the frequency of the spawning of the chokka squid *Loligo vulgaris reynaudii* were estimated from the occurrence and age (time since ovulation) of post-ovulatory follicles in the ovaries and from the number of oviducal eggs. A sample of female squid was jigged on their spawning grounds each hour for 48 hours. Data on oviduct fullness and analysis of the post-ovulatory follicles indicated that chokka squid present a daily timing of spawning, with periods of egg accumulation at night, interrupted by periods of active spawning during the day. The low number of mature eggs and the presence of distinct age classes of degenerating post-ovulatory follicles in the ovaries suggest that ovulation is a rapid process and occurs in small batches. Examination of oviducts and ovaries indicated that individual squid may spawn twice during a period of 36 hours. Ovaries of these spawning individuals contain a wide range of oocytes at different stages of development that may mature and be deposited during the spawning period. It is however unlikely that the entire process is completed over a 24 hour period and a period of ovary recovery is likely, with female squid spawning over weeks or months. More information on the energy allocated to reproduction and growth is needed to understand the dynamic of oocyte growth and spawning.

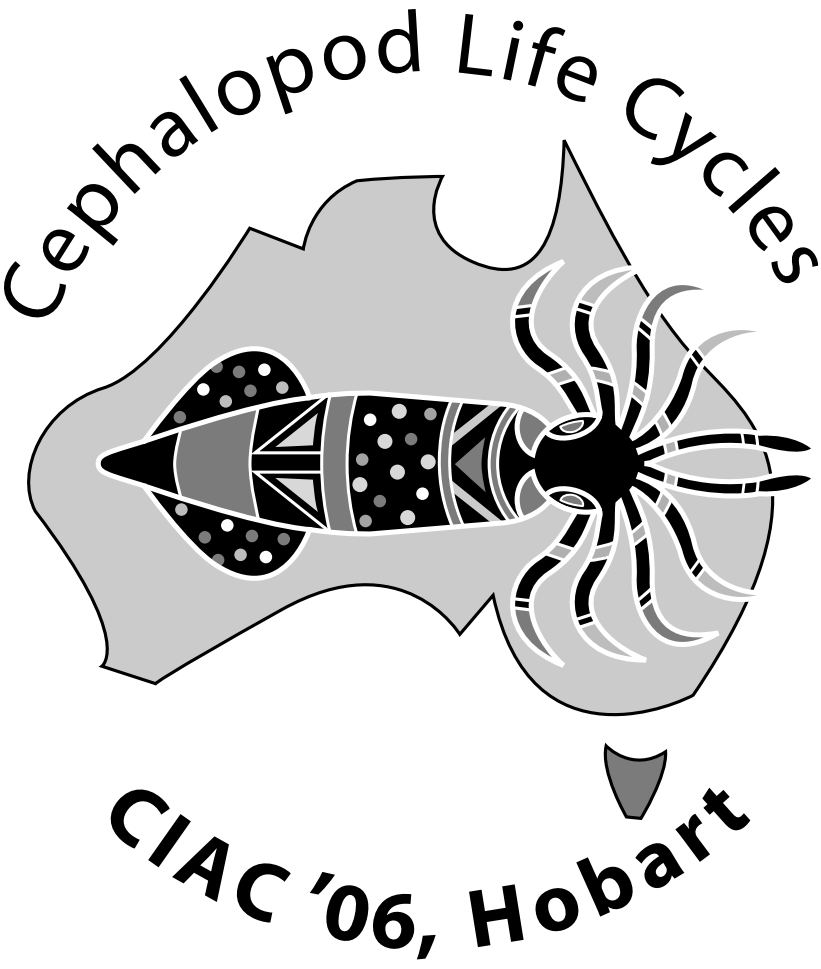
Evidence for multiple year classes of the giant Australian cuttlefish *Sepia apama* in northern Spencer Gulf, South Australia

Karina C. Hall[12], Anthony J. Fowler[1], Michael C. Geddes[2]

[1]South Australian Research and Development Institute, PO Box 120, Henley Beach, SA 5022, hall.karina@csiro.au.

[2]Department of Environmental Biology, University of Adelaide, SA 5005

Giant Australian cuttlefish form a mass spawning aggregation at a single site in northern Spencer Gulf in South Australia every austral winter. Samples of cuttlefish were collected from this region over three consecutive years. Analysis of regular growth increments in the cuttlebones of these individuals, revealed a polymorphism in growth pattern for both sexes. Three distinct "bone types" were identified based on the variation in increment widths over the lengths of the bones. All bones analysed conformed to one of the three bone types, and the increment width patterns were consistent between years. Interpretation of the patterns, suggested that *Sepia apama* have two alternative life cycles. The first involves rapid juvenile growth during the first summer after hatching, with maturity reached within 7-8 months. These individuals return to spawn in their first year as small individuals. The second life cycle involves much slower juvenile growth during the first summer, with maturity deferred until their second year, when they return to spawn as much larger individuals. Thus, the age compositions of populations of *S. apama* in the northern Spencer Gulf appear to consist of two year classes for both sexes.



Poster Abstracts

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Phylogeography of the pharoah cuttle *sepia pharaonis* based on partial mitochondrial 16S sequence data

F.E. Anderson, T. Valinassab, C.W. Ho, C.C. Lu[2]

[1]Department of Zoology, Southern Illinois University, Carbondale Illinois 62901, United States, feander@siu.edu

[2]Department of Life Sciences, National ChungHsing University, 250, Kuo-Kuang Rd., Taichung Taiwan 402, Taiwan, cclu@dragon.nchu.edu.tw

The pharoah cuttle *Sepia pharaonis* is a broadly distributed Indo-Pacific species found from east Africa to southern Japan. The species is extensively exploited across its range, but relatively little is known about the population genetics or biogeography of the species. Evidence from morphology and reproductive biology suggests that *Sepia pharaonis* is actually a complex of at least three closely related species. To evaluate this possibility, we have collected tissue samples from *Sepia pharaonis* from the coasts of Eritrea, Yemen, Oman, Iran, India, Thailand, Malaysia, Taiwan and northern Australia with the help of an international network of collaborators. Partial mitochondrial 16S sequences from these samples, combined with several other *Sepia* 16S sequences from Genbank, reveal a deep split within *S. pharaonis* separating some populations in the western Indian Ocean (e.g., Gulf of Aden) from all other populations. The tree also supports a separation between samples from the western Pacific (e.g., Taiwan) and the central and eastern Indian Ocean samples (e.g., Oman, Andaman Sea coast of Thailand).

Life cycle of *Gonatus antarcticus,* Lönnberg, 1898 in the southwest Atlantic

Alexander Arkhipkin, Vladimir Laptikhovsky

Falkland Islands Government Fisheries Department, PO Box 598, FIPASS, Stanley, FIQQ 1ZZ, Falkland Islands, aarkhipkin@fisheries.gov.fk

Gonatus antarcticus is an abundant pelagic subantarctic squid that can reach a mantle length (ML) of 39.5 cm in its two-year life span. This species spawns during the austral spring in bathypelagic waters of approximately 1,000 m when bottom depth ranges between 1,500-2,400 m. Juveniles (2-6 cm ML) ascend to the epi- and measopelagic layers in summer. Upon maturation, adults migrate back to bathypelagic waters of the continental slope. In some years, juveniles arrive on the Patagonian and Falkland Shelves via the Falkland Current in such large numbers that they are an abundant prey for seabirds and fish. Oocyte maturation of this species is synchronous with intensive oocyte atresion (about 30%) of the initial potential fecundity. Final fecundity ranges between 10,000 and 25,000 eggs while ripe egg size varies from 2.5-2.9 mm to 3.2-3.3mm. Because of the synchronous oocyte maturation and simultaneous ovulation, eggs are not accumulated in oviducts ('traditional' maturity stage V), but only passed through them during spawning. Compared to its North Atlantic congener *G. fabricii, G. antarcticus* is more of an r-strategist because it has smaller eggs and higher fecundity.

Subcellular distribution of some heavy metals (Ag, Cd, Co, Cu, Fe, Mn, Pb and Zn) in the digestive gland of the common cuttlefish *Sepia officinalis*

P. Bustamante[1], M. Bertrand[2], E. Boucaud-Camou[3], P. Miramand[4]

[1]Laboratoire de Biologie et Environnement Marins, Université La Rochelle, Av. Michel Crépeau F-17042 La Rochelle, France, email: pbustama@univ-lr.fr

[2]Institut des Sciences et Techniques de la Mer, Conservatoire National des Arts et Métiers, BP 324, 50103 Cherbourg Cedex, France

[3]Laboratoire de Biologie et Biotechnologies Marines, Université de Caen, 14032 Caen cedex, France

Cephalopods share the ability to accumulate very high levels of several metals such as Ag, Cd, Co, Cu or Zn in their digestive gland. The reasons of such an elevated accumulation remains poorly understood and the mechanisms of storage and detoxification of the metals have been rarely investigated to date. In this work, the subcellular fractionation of the digestive cells of the cuttlefish *Sepia officinalis* was performed in order to investigate the distribution of several metals 1) between organites and cytosol separated by successive centrifugations and 2) in the different cytosolic fractions separated by gel-filtration chromatography. Total metal concentrations vary over 3 orders of magnitudes, ranging from 1µg.g^{-1} dwt for Pb to up 600µg.g^{-1} dwt for Zn. However, with the exception of Cd, Co and Cu, metals were mostly bound to the organites (i.e. > 60%). Fe was mainly associated to the nucleus, brown body, and "boule" fraction (52±3%) and more than 40% of the total Ag was contained in the lysosomal and mitochondria enriched-fraction. The link of all metals with hydrosoluble proteins in the cytosolic fraction was investigated at 254 and 280 nm. Metals are distributed in different profiles along the collected fractions but a high proportion of all elements are related to low-molecular weight proteins. Furthermore, the relative richness of Cd and Cu in metallothionein-like corresponding fractions suggests their involvement in the detoxification of these metals.

The giant squid *(Architeuthis)*: a very high level predator?

P. Bustamante[1]*, K. Das[2], A. Guerra[3], V. Lahaye[1], F. Rocha[3], A.F. González[3] L. Laria[4]

[1]Laboratoire de Biologie et Environnement Marins, FRE 2727 du CNRS, Université de La Rochelle, 22, Avenue Michel Crépeau, 17042 La Rochelle Cedex, France.
email address of corresponding author: pbustama@univ-lr.fr

[2]Laboratoire d'Océanologie, MARE, B6C Université de Liège, 4000 Liège, Belgium.
email address: krishna.das@ulg.ac.be

[3]Ecobiomar. Instituto de Investigaciones Marinas. CSIC. Vigo. Spain.
email addresses: brc1@iim.csic.es ; frocha@iim.csic.es ; afg@iim.csic.es

[4]CEPESMA, Muelle 3, 33700 Luarca, Spain. email address: auladelmar@cespema.com

New insights concerning the giant squid *Architeuthis* are provided by the means of tracers, heavy metals (Ag, Cd and Hg) and stable isotopes (^{13}C and ^{15}N). Four individuals collected off northern Spanish coast and some potential prey (both fish and squid) were analysed. The levels of Hg reached in various tissues are particularly elevated, suggesting either 1) a slow turn-over of the metal which implies that *Architeuthis* would have a longer life span in comparison to other squid species and/or 2) a diet mainly based on fish consumption typically displaying a high bioavailable (i.e. organic) Hg contents. The second hypothesis is consistent with the elevated proportion of organic Hg in the mantle muscle. The relatively low mean Ag and Cd concentrations in its digestive gland (2.36±0.23 µg.g^{-1} dwt and 80.0±2.6 µg.g^{-1} dwt, respectively) would not suggest that cephalopods constitute a large proportion of its diet. Analyses of ^{15}N in *Architeuthis* tissues and prey confirm that this species includes high trophic level fish and squid in its diet, also indicating that it does not feed specifically on Myctophidae. The results here presented suggest that *Architeuthis* could be considered as a very high level predator.

Some information on the distribution and biology of *Illex coindetii* Verany, 1839 (Cephalopoda, Ommastrephidae) in the south-western Adriatic Sea - Central Mediterranean

Luca Ceriola[1], Francesco Toteda[1], Nicola Ungaro[2]

[1]Department of Animal Production, University of Bari – Italy, Via Orabona 4, Bari Italy 70125, email: midamail@tin.it

[2]Laboratory of Marine Biology of Bari – Italy, Via Orabona 4, Bari Italy 70125

In the Adriatic Sea (Central Mediterranean) the short-fin squid *Illex coindetii* (Verany, 1839) is frequently caught by trawlers and contributes to a large part of commercial cephalopod landings. Nevertheless, most aspects of the life history of *I. coindetii* in the area are poorly investigated. Information on the distribution and biology (growth, sexual maturity, length-weight relationship) of *I. coindetii* are reported for the south western Adriatic Sea. Samples came from six experimental bottom trawl surveys carried out within the framework of the Medits programme (1997-2002). Although specimens have been collected at a wide depth range, *I. coindetii* concentrates between 50 and 200 m. No differences in sex ratios have been highlighted when considering the overall population, but a general dominance of females over males at larger size, and of males over females at smaller size was evident. The studied population displayed a broad spawning season, and a pronounced sexual dimorphism. Females mature at larger mantle length, attain larger size and show a faster growth than males. Examination of the length-weight relationship revealed a difference between sexes once the maturation process starts. Immature specimens exhibited negative allometric growth in both sexes, whilst in maturing and mature males growth was positively allometric and isometric in females.

Ecosystem influences on English Channel squid recruitment variability investigated by multivariate time-series methods

Laurence Challier .[1], Graham J. Pierce[2], Jianjun Wang[2], Beatriz Roel[3], Jean-Paul Robin[1]

[1]Laboratoire de Biologie et Biotechnologies marines, Institut de Biologie et Biochimie appliquée, Université de Caen, esplanade de la Paix, 14032 Caen Cedex, France, email: jean-paul.robin@unicaen.fr

[2]School of Biological Sciences (Zoology), University of Aberdeen, Tillydrone Avenue, Aberdeen AB24 2TZ, UK, email: g.j.pierce@abdn.ac.uk

[3]CEFAS, The Centre for Environment, Fisheries and Aquaculture Science, Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk NR33 0HT, UK, email: B.A.Roel@cefas.co.uk

The English Channel *Loligo forbesi* squid biomass and catch shows large seasonal and inter-annual fluctuations, which reflect changes in the ecosystem. Recruitment abundance variation was investigated using climatic variables and indices describing other marine species, which were components of the English Channel ecosystem. Squid population abundance was estimated with France and UK commercial catch data using monthly cohort analysis for a series of 14 fishing seasons (1989-2003). The relationships between time-series of squid abundance and biotic/abiotic variables were explored using dynamic factor analysis. The main climate variability introduced were sea surface temperature (SST), the North Atlantic Oscillation (NAO) and wind stress. Biotic variables concerned other cephalopods that are caught in the English Channel like *Loligo vulgaris* and *Sepia officinalis* and finfish species that were examined to test hypotheses of inter-specific competition. *Loligo forbesi* abundance fluctuations are discussed in the light of published information on habitat changes.

Reproductive biology of *Uroteuthis (Photololigo) duvauceli* in Hong Kong waters: or, the mystery of where squid spawn…

Wallace Choi[1], Cynthia Yau[1]

[1]The Swire Institute of Marine Science, Department of Ecology & Biodiversity, The University of Hong Kong, Cape d'Aguilar, Shek O, Hong Kong, email: wallace_choi@hkusua.hku.hk, cynthia-yau@hkucc.hku.hk

The loliginid squid *Uroteuthis (Photololigo) duvauceli* (Orbigny, 1835) is the target of a recently developed, small-scale recreational jig fishery in the eastern waters of Hong Kong, where it forms inshore aggregations in summer, reputedly for spawning. Although this species is also commonly caught in commercial fisheries, its biology in this region is unknown. Length-frequency and length-weight relationships, gonado-somatic and hepato-somatic indices, and fecundity were recorded from monthly trawl samples between April - August. The maximum size of males and females are 151 mm and 131 mm ML respectively, while the sex ratio is female biased. GSI results indicate maturation commences in spring and reaches a maximum in summer. Mature individuals were present in all 5 months but peaked between June - July. Multiple cohorts were recorded in the population between July - August, with juveniles recruiting to the fishery at 26 mm ML. Statolith ageing indicates a life span <1 year. Conflict exists between commercial fishermen and jigging operators over catches of *U. (P.) duvauceli* and potential disturbance to spawning grounds by trawlers, however, an ongoing SCUBA dive survey has yet to locate the spawning grounds of the squid.

Temperature-dependent growth of *Loligo bleekeri* statoliths through hatching

Hiroko Furukawa[1], Yasunori Sakurai[2]

[1]Planning Department, Hakodate City Hall, Hakodate, Hokkaido, 040-0036, Japan;
e-mail: h-d-furu@sea.ncv.ne.jp

[2]Graduate School of Fisheries Sciences, Hokkaido University, Hakodate, Hokkaido, 041-8611, Japan;
e-mail: sakurai@fish.hokudai.ac.jp

Reproductive success in squids is thought to depend on environmental temperature during the embryonic and hatching stages, but little is known about the relationship between temperature and statolith growth during these stages. The present study examined how temperature affects the growth of statoliths in embryos and hatchlings of *Loligo bleekeri* (Cephalopoda: Loliginidae). Statoliths were obtained from embryos and hatchlings maintained at four temperatures (10, 12, 14, and 16˚C). The duration from the start of statolith formation to hatching was 40.8 days at 10˚C, 27.8 days at 12˚C, 21.2 days at 14˚C, and 16.5 days at 16˚C. However, statolith size at hatching (i.e., the distance from the focus to the natal ring in the lateral dome) and total effective temperature from the start of statolith formation to hatching were not affected by temperature. The natal ring was observed in statoliths within a day after hatching, and daily growth increments formed outside of this ring. The increment widths increased in size with increasing temperature (2.58 at 10˚C, and 6.24 at 16˚C), which suggests that it might be possible to use increment width to estimate the environmental temperature experienced after hatching.

Mass stranding of *Argonauta* spp. (Cephalopoda: Argonautidae) in the Gulf of California, MÈxico

Andrés Gonzalez Peralta.

Universidad AutÛnoma de Baja California Sur, Departamento de BiologÌa Marina,
Apartado postal 19-B, CP 23080 La Paz, B.C.S, Mexico email: aperalta98@prodigy.net.mx

Species of the genus *Argonauta Linnaeus,* 1758 are widespread in tropical areas of the world oceans, but most of the available biological information about them consists of isolated records of their presence in specific localities. This paper describes the mass stranding of 3 species of *Argonauta (A. cornuta, A. nouryi* and *A. pacifica)* that occurs every year in winter and early spring at BahÌa de La Paz , Golfo de California, MÈxico (24˚ N). That year, *Argonauta* shells were found at 14 localities in the bay, and at a variety of sites from 23˚ to 25˚ N on the east and west shores of the gulf. Shells of *A. nouryi* were the most abundant, whereas the shells of *A. pacifica* were the largest. Shell weight, maximum shell length, and aperture length and width were significantly correlated in all species. In general the relationships followed a power function. Annual stranding in the southern Gulf of California are assumed to occur when individuals ascend to the surface to reproduce, are transported to the coast by the wind and water movement, and finally are washed up on beaches at low tide.

Fall spawning grounds of the ommastrephid squid *Todarodes pacificus* during periods of large stock size

Tsuneo Goto

Japan Sea National Fisheries Research Institute, Fisheries Research Agency, 1-5939-22 Suido-cho, Niigata-shi, Niigata, Japan, 951-8121, tsuneog@affrc.go.jp

The results of previous paralarval surveys (1972-91) of the Japanese common squid *(Todarodes pacificus)* in the southern Sea of Japan suggest that the spawning grounds occur in Japanese coastal waters when the stock size is small but expand into the northern East China Sea when the stock size is large. No surveys have been carried out in Japanese coastal waters after the 1990s when the stock size was large, so in fall of 2003 and 2004, we conducted surveys focusing on coastal waters. Our results show that the spawning grounds were influenced by oceanographic conditions such as water temperature. These results and those of other surveys focusing on a smaller area near the Korea Strait since 1992 confirm that spawning occurs in the northern East China Sea when the stock size is large.

Seasonal variation in biochemical composition of the cuttlefish *Sepia officinalis* from NW Spain

Ángel Guerra[1] , Vera Bettencourt[1], Ángel F. González[1], Francisco Rocha[1]

[1]ECOBIOMAR. Instituto de Investigaciones Marinas, CSIC, Eduardo Cabello 6, 36208 Vigo, Spain, email: brc1@iim.csic.es, brc1@iim.csic.es, afg@iim.csic.es, frocha@iim.csic.es

RNA, DNA, protein and water content of *Sepia officinalis* mantles from Ría de Arousa (NW Spain), were analysed in two seasons of the year, autumn and spring. This study allowed the evolution of biochemical indices throughout the life cycle of the species to be followed, showing that sex does not affect any of the studied parameters, whereas they were affected by seasons. RNA, DNA and protein content present lower values in individuals collected in spring. On the contrary, water content was higher when comparing with individuals collected in autumn. Sexual maturation influences the nucleic acids concentration. A clear decrease in RNA and DNA content with the evolution of sexual maturation was found. However, water and protein content were not influenced by sexual maturation.

Cephalopods sampled during the DIVA-II expedition of *RV Meteor* in the tropical Atlantic during March 2005

Jürgen Guerrero-Kommritz[1], Uwe Piatkowski[2]

[1]Zoologisches Institut und Zoologisches Museum, Universität Hamburg, Martin-Luther-King-Platz 3, 20146 Hamburg, Germany, http://www.biologie.uni-hamburg.de/zim, email: greledone@hotmail.com

[2]Leibniz-Institut für Meereswissenschaften (IFM-GEOMAR), Düsternbrooker Weg 20, 24105 Kiel, Germany, www.ifm-geomar.de, email: upiatkowski@ifm-geomar.de

In March 2005 an extensive deep-sea trawl programme was conducted by RV "Meteor" during the DIVA-II expedition in the tropical Atlantic Ocean. Sampling concentrated in the Cape Basin south of the Walvis Ridge and in the southern Guinea Basin, and the standard gear to sample macro-benthos in depths between 5017 and 5142 m was an Agassiz trawl. At six stations with this trawl and probably during hauling in the gear 20 pelagic cephalopods were captured in the ascending trawl. They belonged to the families Pyroteuthidae, Lycoteuthidae, Onychoteuthidae, Histioteuthidae, Mastigoteuthidae, Cranchiidae, and Bolitaenidae *(Japetella diaphana)*. During a night-station south of the Guinea Basin two Ommastrephidae *(Sthenoteuthis pteropus)* were captured by hand-jigging. The presentation provides information on species and distribution of cephalopods from a unique collection at oceanic sites in the tropical Atlantic Ocean.

Impact of commercial fishing on the population structure of *Sepioteuthis australis*

Ty Hibberd[1], Gretta T. Pecl[2]

[1], Institute of Antarctic and Southern Ocean Studies, University of Tasmania, Private Bag 77, Tasmania, Australia, 7001, Ty.Hibberd@utas.edu.au

[2], Marine Research Laboratories, Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, Private Bag 49, Tasmania, Australia, 7001, http://www.utas.edu.au/tafi/Profiles_MRL/TAFI_Gretta_Pecl.htm, Gretta.Pecl@utas.edu.au.

The commercial fishery for southern calamary in Tasmania primarily targets spawning aggregations that occur in shallow sheltered bays over the austral spring and summer. This study explored the impact of commercial fishing on the population dynamics to establish short-term changes in size, population structure, or reproductive parameters, in relation to fishing pressure. Management concerns for the sustainability of the southern calamary fishery in Tasmania has led to three-month closures of major spawning grounds annually, thus allowing population dynamics to be examined on a fine temporal scale before, during, and after the closure. Fishing pressure was clearly responsible for major changes in the population dynamics of southern calamary. Sex-ratio was more even both before and after the closure, however, during the closure males out-numbered females 10:1. Acoustic tracking data revealed differential habitat use by the sexes, where males were accumulating on the beds, as opposed to more frequent movement on and off the beds by females. Therefore, although fishing was removing a representative sample of what was on the beds at any point in time, the fishery was effectively selective for males and subsequently had a major impact on both the apparent size of individuals and sex-ratio of the population.

The doratosepion species complex (Cephalopoda: Sepiidae) in the waters of Taiwan

Ho Chuan-Wen

Graduate Institute of Ecology and Environmental Education, National, 123 Hua-His, Hualien Hualien 970, Taiwan, email: cch@mail.nhlue.edu.tw

Nine species of cuttlefish belonging to the "doratosepion" species complex have been recently recognized from the waters around Taiwan based on morphological and molecular methods. Previously seven doratosepion species had been recorded (Kubodera and Lu, 2002), including *Sepia (Doratosepion) foliopeza* Okutani & Tagawa, 1987, *S. (D.) kobiensis* Hoyle, 1885, *S. (D.) longipes* Sasaki, 1913, *S. (D.) pardex* Sasaki, 1913, *S. (D.) tenuipes* Sasaki, 1929, *S. (D.) vietnamica* Khromov, 1987 and one undescribed species: *S. (D.)* sp. *TW1*. *Sepia (D.)* sp. *TW1* has a pair of elongated "tails" at the posterior end of fins. This is a unique character that differentiated the species from all other *Doratosepion* species. Recently it has been found that the *S. (D.)* sp. *TW1* comprises two species, *S. (D.) furcata* Ho & Lu, 2005 and *S. (D.) hirunda* Ho & Lu, 2005. In this study, further molecular evidence based on partial mitocondrial cytochrome c oxidase subunit I DNA sequences indicates *S. (D.) hirunda* has a phenotype that has no "tails". Two additional species new to science are also found in this study: *S. (D.)* sp. nov. TW21 and *S. (D.)* sp. nov. TW23 which are described here. Comparisons of morphology, partial mtCOI sequence and distribution of these species are provided.

Age, growth and reproduction of southern African *Lycoteuthis lorigera* (Steenstrup, 1875)

H.J.T. Hoving[1], M.R. Lipinski[2], M.A.C. Roeleveld[3], M.D. Durholtz[2], Y. Melo[2],

[1]Biological Centre, Department of Marine Biology, University of Groningen,
P.O. Box 14, 9750 AA Haren (Gn), The Netherlands, email: H.J.T.Hoving@rug.nl

[2]Marine and Coastal Management, Private Bag X2, Roggebaai 8012, Cape Town 8000, South Africa,
email: Lipinski@deat.gov.za, Durholtz@deat.gov.za

[3]Iziko Museums of Cape Town, P.O. Box 61, Cape Town 8000, South Africa, email: Martina@iziko.org.za

Lycoteuthis lorigera shows striking sexual size dimorphism, with males attaining almost twice the size of females. About 100 animals (consisting of maturing and mature females, immature males and juveniles) have been aged from statoliths. Mature females had a mantle length 88-105 mm, corresponding with an age of 290-314 days. The mantle length of (formalin preserved) mature males was 136-194 mm (no statoliths were available for age determination). The instantaneous growth rate (based on an exponential growth curve) was 0.52% ML/day, corresponding very closely with growth rates reported for enoploteuthids. Histologically the ovary of mature females showed developmental stages of oocytes as well as fully developed ova, suggesting more than one spawning event. The morphology and location of the seminal receptacle is described. Males are unusual among squids in having paired spermatophoric complexes; both Needham's sacs are short and the testes are very small (maximum preserved mass 0.6 g). The role of the very long second and/or third arm pair in the transfer of spermatophores is discussed. Males are rare in trawl catches where females are abundant, perhaps because males live in separate cohorts, are more difficult to catch, or because the sex ratio of the population is skewed.

Interannual catch fluctuations of *Loligo bleekeri* in northern Japan related to changing environmental conditions in coastal waters

Kingo Ito[1], Yasunori Sakurai

[1]Aomori Prefectural Fisheries Research Center, 196 Akaishi Oowada, Ajigasawa Aomori 038-2731, Japan,
email: kingo_ito@ags.pref.aomori.jp

[2]Graduate School of Fisheries Sciences, Hokkaido University

There are two populations of *Loligo bleekeri* in northern Japan with different peak spawning seasons (winter and spring) and coastal migration routes (winter stock: from the Sea of Japan through Tsugaru Strait to the Pacific Ocean; spring stock: within the Sea of Japan). Our study compared annual catches of the two populations with coastal water temperatures and currents (the Tsugaru Warm Current and Coastal Oyashio) during 1985-2002. Catches of both stocks were positively correlated with the strength of the Tsugaru Warm Current during the spawning-recruitment seasons; when the flow was strong, catches were high for the winter stock along the coast of Tsugaru Strait, Funka Bay (Hokkaido Island) and northern Honshu Island, and for the spring stock along the coast of Aomori prefecture (northern Honshu Island) in the Sea of Japan, Tsugaru Strait and Pacific Ocean. Coastal water temperatures during the hatching-recruitment seasons were positively correlated with annual catches of both stocks.

Identification, distribution, and relative abundance of paralarval gonatid squids from the Gulf of Alaska, 2001-2003

Elaina Jorgensen,
University of Washington/NOAA, 7600 Sand Point Way NE, SEATTLE WA 98115, UNITED STATES, EMJ1@u.washington.edu

Paralarvae of the family Gonatidae (Cephalopoda: Oegopsida: Gonatidae) were sampled in the Gulf of Alaska during the spring in 2001-2003. Taxonomic characters were determined to allow identification of the specimens to species. The dorsal head chromatophore pattern (DHCP) was the most robust character and allowed identification to species for the first time without requiring the removal and examination of the radula. Six DHCPs were found among the six species in the study area. The 1140 specimens collected consisted of six species: *Berryteuthis anonychus* (761), *B. magister* (71), *Gonatopsis borealis* (154), *Gonatus kamtschaticus* (1), *G. madokai* (3), and *G. onyx* (143). The specimens had a size range of 3.3 to 20.63 mm (dorsal mantle length) with the majority of specimens smaller than 10 mm. All species showed an increasing trend in abundance from the shelf (0-200 m) to the slope (200 - 1000 m) to the basin (> 1000 m) except *G. onyx* in 2001 and 2002. Wide variation in distribution and abundance was found for the four most abundant species; however, in general, *B. anonychus* was most abundant and widely distributed, followed by *G. borealis, G. onyx,* and *B. magister.*

Bio-economic modelling of the Mauritanian octopus fishery

Jouffre, Didier and others
IRD (Institut de recherche pour le développement), DAKAR, Unité OSIRIS, Centre De Bel Air, Bp 1386, Senegal

A bio-economic model of the Mauritanian octopus fishery has been developed. The biological basis of the model is an adaptation of an existing analytical model, i.e. a production model designed explicitly for octopus biology and the observed exploitation pattern (age-based model, computed on one monthly step, etc). In the current version of the model, both the biological and economic components of the model have been designed to reflect the fleet structure, with one small-scale and three industrial fleet segments. The economic component of the model is based on the prices received by, and the operating (opportunity) costs of, each segment. When coupled with the biological component, this allows an estimation of resource rents per segment associated with different exploitation levels and fleet structures. Within the context of a new management plan for the Mauritanian octopus fishery, the model enables an overall assessment of the management system to be made, and can simulate the likely impact of a range of management measures.

Spawning mode and reproductive output of the Japanese pygmy squid *Idiosepius paradoxus* (Cephalopoda: Idiosepiidae)

Takashi Kasugai

Port of Nagoya Public Aquarium, Nagoya 455-0033, Japan, email: t-kasugai@nagoyaminato.or.jp

The Japanese pygmy squid *Idiosepius paradoxus* is the most northern species in the genus *Idiosepius,* and is known have at least two generations within one year at the temperate coast of central Honshu, Japan, namely a large sized generation in spring and a small sized generation in summer Kasugai and Segawa, 2005. This study investigated the spawning mode and reproductive output of *I. paradoxus* in wild specimens collected in spring and summer and separately maintained in aquaria. Captive females produced multiple egg batches and a large number of eggs. On average, 853 eggs in 14 batches over 32days and 342 eggs in 20 batches over 32 days were produced in spring and summer individuals respectively. The maximum number of egg batches laid, longest duration of egg-laying, and largest total number of eggs laid by an individual was 42 batches, 70 days and 2111 eggs respectively. As a result of this study, *I. paradoxus* as very small squid are called "maximalists" in terms of their reproductive output like other *Idiosepius* species

Early life stages of the Gonatidae (Teuthida: Oegopsida): ontogenetic changes in external morphology

O.N. Katugin, G.A. Shevtsov

Pacific Research Fisheries Centre (TINRO-Centre), 4 Shevchenko alley, Vladivostok 690 950, Russia,
email: okatugin@mail.ru, katugin@tinro.ru

Squids of the family Gonatidae are highly abundant in cold waters of the Northern and Southern hemispheres. However, rather fragmentary information exists on early ontogenetic stages of gonatids. In this study, we examined changes in external morphology of the Gonatidae from post-paralarval to juvenile (and, where necessary, to immature adult) stages, with particular consideration of fin, arms, tentacles and body proportions. Special attention was given to the size at which armature on tentacles and arms develop in different species. Morphology of early life stages of the following 13 taxa have been analyzed (mantle length ranges are given in parentheses): *Berryteuthis magister* (18-58 mm), *Okutania anonycha* (31-86 mm), *Gonatopsis borealis* (7-67 mm), *Gonatopsis* sp. (7-35 mm), *Gonatopsis octopedatus* (11-31 mm), *Gonatopsis japonicus* (26-67 mm), *Gonatus madokai* (4-34 mm), *Gonatus berryi* (53 mm), *Gonatus* cf. *kamtschaticus* (short-armed form) (36-59 mm), *Gonatus* cf. *kamtschaticus* (long-armed form) (24-70 mm), *Gonatus onyx* (5-77 mm), *Gonatus pyros* (25-62 mm), *Gonatus tinro* (7-44 mm), and *Gonatus antarcticus* (23-31 mm).

Spatial and vertical distribution of cephalopods in the western Bering Sea in autumn 1990

O.N. Katugin, N.N. Zuev, V.D. Didenko

Pacific Research Fisheries Centre (TINRO-Centre), 4 Shevchenko alley, Vladivostok 690 950, Russia, email: okatugin@mail.ru, katugin@tinro.ru

Cephalopods are important components in the Bering Sea pelagic ecosystems. Patterns of spatial and vertical distribution of cephalopods were obtained from a large-scale trawl survey conducted in the western Bering Sea in October-November 1990. Of fourteen cephalopod species captured in the upper 500 m layer, ten belonged to the squid family Gonatidae: *Berryteuthis magister, Gonatopsis borealis, Gonatopsis* sp. *(cf. makko)*, *Gonatopsis octopedatus, Gonatus tinro, Gonatus madokai, Gonatus berryi, Gonatus kamtschaticus, Gonatus onyx,* and *Gonatus pyros.* Two species represented the squid family Cranchiidae: *Belonella borealis* and *Galiteuthus phyllura*, and one species was a pelagic octopod *Japetella diaphana*. All cephalopod species were much more abundant in the mesopelagic zone (200-500 m) than in the epipelagic zone (0-200 m). Gonatid squids totally dominated in cephalopod catches. Clear distribution patterns were revealed in several highly abundant species: demersal *B.magister* were associated primarily with lower shelf and upper slope areas, rarely occurring over deep-sea areas; pelagic *G.borealis* were widely distributed in offshore areas and conducted intensive diel vertical migrations; *G.tinro* showed clear ontogenetic descent from upper to lower pelagic layers at the onset of maturation.

Study on the postmortem change in skin colour of squid *Todarodes pacificus:* development of techniques for the preservation of squid

Yasunori Kinoshita[1], Takeya Yoshioka[1], Kunihiko Konno[2], Yasunori Sakurai[2]

[1]Division of Seafood Processing, Department of Research and Development, Hokkaido Industrial Technology Center, 379, Kikyo-cho, Hakodate, Hokkaido, Japan. 041-0801 e-mail:kinoshita@techakodate.or.jp, yoshioka@techakodate.or.jp

[2]Graduate School of Fisheries Sciences, Hokkaido University, 3-1-1, Minato-cho, Hakodate, Hokkaido, Japan. 041-8611 e-mail: konno@fish.hokudai.ac.jp, sakurai@fish.hokudai.ac.jp

Body colour of squid changes quickly after death. Thus, traditionally the change in skin colour has been "used as a sensitive and characteristic index of freshness for squid. However, there is little information what is the biochemical background of the change, and what is the scientific method to evaluate the colour change. The understanding of the events is essential for the development of the technology to preserve squid in very fresh state. A live squid was instantly killed, and was stored at various temperatures in air and in seawater. Change in the skin colour was monitored by taking a photo regularly. White and black areas in the field were estimated on PC as an index of colour development. Colour developed in 24hr and decreased gradually when stored at 5°C in air. However, colour development was kept high when stored in seawater for at least 7days. It was concluded that storage of squid in seawater was very effective in keeping the colour development. We noticed that the chromatophore on squid skin responded to the stimulation for a quite long period (7days) after death showing a flushing of the chromatophore. It was suggested that the nervous system is functional for a long period after death when stored in seawater.

The ontogenetic dynamic of steroids hormones quantitative contain in squid and octopus

Natalie Kudikina

Kaliningrad State University, Universitetskaja st.,[2] Kaliningrad 236000 Russia, email: ecology@email.ru

Steroids hormones have high controlling and regulating physiological activity and are involved in numerous processes in the organism: they support normal development and functioning of the reproductive system, regulate the processes of total metabolism and supply specific and nonspecific organism adaptations to changing habitat. Published data on steroid hormones in cephalopods are very scarce. This study quantified sexual hormones (testosterone and progesterone) and glucocorticoids (hydrocortisone and corticosterone) in different parts of the reproductive systems, systematic heart and "liver" of ommastrephid squids (*Todaropsis eblanae, Illex illecebrosus*) and octopus (*Octopus vulgaris*) that were at different stages of sexual maturity. In males and females of all studied species the distinct differences in the quantities of hormones in similar and analogous organs were noted. Besides those organs with different functional roles, differences in the concentration of hormones were established. During ontogenesis maximal concentration of hormones were observed in the heart, with intermediate concentrations of sexual hormones in the reproductive organs, and only trace concentrations of sexual hormones in the "liver". Hormonal concentration in all organs decreased with maturation in both males and females. The studied traits are similar in *Illex* and *Todaropsis,* and significantly differ between squid and octopus.

Methodology of loliginid statolith data processing for ageing studies

R. Laubscher, D. Durholtz, M.R. Lipinski

Marine and Coastal Management, DEAT, Private Bag X2, Roggebaai 8012 Cape Town, South Africa, www.mcm-deat.gov.za, email: lipinski@deat.gov.za;

The counting of statolith increments in the chokka-squid *Loligo reynaudii* as a tool for age determination is well documented. Statolith samples vary in quality according to preparation and the statolith's intrinsic properties (increment clarity, presence of sub-daily rings, imperfections, etc.). Grading the sample datum allows a database to be constructed where data quality can be defined and rules of inclusion established based on a minimum quality requirement being reached. However, this also means that a subjective sorting step is required where the risk of bias is a possibility. In order to reduce the effect of bias, a two-step process in classifying the sample datum has been developed that incorporates a weighting of both subjective and objective grading criteria. Subjective classification grades a sample from 0 to 5, where 0 = no sample,1 = partially readable, 2 = large portion of increments determined by interpolation and extrapolation, 3 = major portion of the statolith is clear, but unclear areas exist and some interpolation and extrapolation is required, 4 = majority of increments are countable, but minor extrapolation and interpolation may be needed, 5 = entire statolith is countable. Objective classification is based on the percentage of statolith increments that is estimated by interpolation and extrapolation. Samples are graded from A to D where A = <5% interpolated or extrapolated, B = 90 to 95% of sample is interpolated or extrapolated, C= 80 to 89% of sample is interpolated or extrapolated, D = 50 to 79% of sample is extrapolated. A two-by-two matrix combines the two grading systems and generates an alphanumeric value from a set containing the values A5, A4, B5, B4, A3, B3, C3, D3, D2. This set is equivalent to the weighted numerical value set 5, 4, 4.75, 3.8, 3, 2.85, 2.4, 1.5, 1, with the highest value indicating the highest quality rating. Data can be excluded by setting the minimal acceptable weighted grade rather than considering individual samples. In the process of developing this methodology, a total of 484 statoliths were prepared of which 427 produced data (88%). Of this, 9% were graded from 4.5 to 5, 49% from 3.5 to 4.4, 36% from 2.5 to 3.4 and 6% from 1.5 to 2.4.

Valorisation of waste from cuttlefish transformation.

E. Le Bihan, N. Koueta

Laboratoire de Biologie et Biotechnologies Marines, UMR 100 IFREMER, Physiologie et Ecophysiologie des Mollusques Marins. Université de Caen. 14032 Caen cedex, France, estlebihan@yahoo.fr

France is the 1st European producing (5th word rank) of cuttlefish with 12300 tones in 2001. In France, principal production of cuttlefish was situated in west littoral. Different processes as hydrolyze or autolyse permit, from fish wastes, the production of supplement able to stimulated growth of different species rearing in aquaculture. Physiology of cephalopods, which are evolute mollusks, is similar to this of fish. Then, cuttlefish was a good candidate to the valorisation of fishing wastes. Autolysates (from cuttlefish wastes) were made in our laboratory and assayed *in vivo* (experimental rearing) and *in vitro* (isolated cells). *In vivo,* juvenile diet enrichment with autolysate permits high stimulation of growth parameters. *In vitro,* medium culture supplementation of marine invertebrate isolated cells with autolysate, allowed to stimulated cell viability. Our results showed the real interest of autolysate utilization in diet or cell culture medium supplementation.

Fisheries and demographic structure of *Loligo vulgaris* in the Mediterranean Sea

Eugenia Lefkaditou

Hellenic Centre for Marine Research, Aghios Kosmas, Heliniko, Athens Attiki GR-16604, Greece.
email: teuthis@ath.hcrnr.gr

Data on landings of *Loligo vulgaris,* fishing effort and length distribution were collected monthly (July 1998-June 1999) from fishing fleets operating in the Thracian (Greece, eastern Mediterranean) and the Ligurian (Italy, western Mediterranean) Seas.

L.vulgaris was exploited in the Thracian Sea from October to May by bottom trawl and beach seine, with higher CPUE for the latter fishing gear. The analysis of length frequency data indicated that landings consisted of one year class recruited in summer, with differentiation of modal peaks for the two sexes from December and forward. Migration of larger individuals towards the coast was observed at mid autumn, but almost equal distribution of the population in beach-seine and trawl fishing grounds during winter and early spring. Interaction between the two gears was only noted in winter. There were significant differences in mantle lengths caught by the two fishing gears during the rest period of the study.

In the Ligurian Sea practically all the catch of *L.vulgaris* was coming from trawling. Mature specimen were found all year round, whereas juveniles were recruited almost continuously from July to February, dominating the catches in July.

CPUE was characterized by a clear seasonality in both areas investigated, with higher values in autumn, a constant decline during winter and negligible values in spring due most probably to the high post spawning mortality of this species.

New findings of female *Ocythoe tuberculata* in the northeastern Mediterranean

Eugenia Lefkaditou

Hellenic Centre for Marine Research, Aghios Kosmas, Heliniko, Athens Attiki GR-16604, Greece.
email: teuthis@ath.hcrnr.gr

New findings of *Ocythoe tuberculata* (Rafinesque 1814) from the Aegean Sea (NE Mediterranean) are reported. Five females, with mantle length ranging between 21 and 30.5 cm, were found by fishermen, stranded, floating or caught by nets near shore at five different locations, from May to July 2005. The specimen were measured and weighted fresh or after preservation in refrigeration; beak dimensions were also measured. Dissection of larger females brought out large ovaries full of eggs with developing embryos. Eggs size ranged from 1,0 to 1,3 mm in major axis.

A review of the findings of *O. tuberculata* to date revealed that most of them concern females collected during late spring and early summer. Periodicity of the species findings in the Aegean Sea is discussed in relation to the sea surface conditions and the species biological characteristics.

Identification of cephalopod fauna of the Archipelago of Saint Peter and Saint Paul, the most isolated island in Brazil

T.S. Leite[1], L.C.A. Andrade[2], R.A. Santos[3], M. Haimovici[1] J.E. Lins Oliveira[2]

[1]Pós-Graduação de Oceanografia Biológica, Laboratório de Recursos Demersais e Cefalópodes FURG, Caixa Postal 474 , Rio Grande /RS Brasil, E-mail leite_ts@yahoo.com.br

[2]Universidade Federal do Rio Grande do Norte- Laboratório de Biologia Pesqueira: E-mail: jorgelins@ufrnet.br, lorenacandice@yahoo.com.br

[2]IBAMA/CEPE-SUL, gibteuthis@yahoo.com.br

Only a few species of cephalopods have been recorded for the Archipelago of Saint Peter Saint Paul (ASPSP), located 1100 km from the mainland and considered an important local resource to commercial fisheries and marine researchers because of the strategic location and isolation in the middle of the South Atlantic. To identify the cephalopods around these islands we analysed the stomach contents of pelagic fish caught with hand line by commercial fisheries boats. A total of 271 beaks in 103 stomachs from seven different species, mainly *Thunnus albacares* were examined. Thirty six distinct taxa of cephalopods were identified, including 19 to species and 11 to genera. The family Ommastrephidae was the most common (53.5%), and the *Ornitotheuthis antillarum* the principal species (44.9%). Other common families were Histioteuthidae (8.3%), Enoplotheuthidae (6.9%), Bolitenidae(6.5%). The results showed the large biodiversity of cephalopods around the islands.

The small scale fishery of octopus at Fernando De Noronha Islands off northeastern Brazil

T.S. Leite[1], H. Haimovici[1], J.E. Lins Oliveira[2]

[1]Pós-Graduação de Oceanografia Biológica, Laboratório de Recursos Demersais e Cefalópodes FURG, Caixa Postal 474 , Rio Grande /RS Brasil, E-mail leite_ts@yahoo.com.br

[2]Universidade Federal do Rio Grande do Norte- Laboratório de Biologia Pesqueira: E-mail: jorgelins@ufrnet.br, lorenacandice@yahoo.com.br

The archipelago of Fernando de Noronha, 350 km offshore northeastern Brazil, have a small scale fishery for octopus in the shallow waters off its narrow shelf outside the National Park, which covers 2/3 of its surface of 17 km^2. As a part of a wider scope study of the shallow water octopuses, the impact of the fishery was studied between 2003 and 2005. Fishers and buyers were interviewed periodically for information on the fishing sites, effort, catch, and consumption. The stable population consists of 3000 habitants, along with up to a maximum of 500 tourists, including 46 octopus fishers, the most sporadic. These fishers, between 18 and 42 years old, collect octopus by diving (snorkeling) on average two times a week with a mean catch of 7.95 kg of octopuses. A rough estimate of the total yearly catch is at least 3,148 kg. Interviewed restaurant and hotels suggest a consumption of around 154 kg of octopus per week, thus the local fishery can provide <20% of the demand. Due to the high fecundity of the species and low accessibility to divers it was concluded that a conservation plan is compatible with a small number of authorized fishers.

Elements of behaviour of loliginid squid in a large concentration

M.R Lipinski[1], M. Soule[2]

[1]Marine and Coastal Management, DEAT, Private Bag X2, Roggebaai 8012 Cape Town, South Africa, www.mcm-deat.gov.za, email: lipinski@deat.gov.za;

[2]Fisheries Resource Surveys, P.O. Box 31306, Tokai 7966 Cape Town, South Africa, email: frs@new.co.za.

During hydroacoustic observations in November 2002, a large concentration of chokka squid *(Loligo reynaudii)* was monitored for 3 days in a good weather. During this period, the whole concentration (estimated biomass 48 t) disintegrated into small, separated aggregations. Most often, such dispersal is weather-related. In this case, bottom trawls made next to the concentration as well as underwater camera observations revealed unusually large number of predators, mostly bronze whaler sharks *(Carcharhinus brachyurus)*. Most of those, which were found in the trawl, had chokka in their stomachs. Therefore, the only explanation for the break-up of this squid concentration is the unusual activity of predators. Video observations have revealed, that most of these attacks had occurred on the bottom where squid spawn, and little in the water column where squid pair, mate and swim in the circular motion preparing for descent to the egg bed. The disintegration of the whole concentration suggests that disrupted spawning affects the upper part of the mushroom structure as well and squid disperse and/or move away as a result.

Hatching dates and the timing of spawning in the chokka squid

M.R. Lipinski, R. Laubscher, D. Durholtz

Marine and Coastal Management, DEAT, Private Bag X2, Roggebaai 8012 Cape Town, South Africa, www.mcm-deat.gov.za, email: lipinski@deat.gov.za

The management of chokka squid *(Loligo reynaudii)* fishery is effort-based. One of the tools of this management is a closed season between 18 (or 25) October and 22 November each year. It has been argued, that this period allows chokka squid to stabilize (after disruption by fishery), concentrate and lay huge numbers of eggs. In this way, the critical abundance of the next generation is secured. This assumption was tested using chokka statoliths for reading the age in days, and back-calculating birthdates for squid, collected from the large concentrations during the closed season. It was expected to find prevailing number of birthday dates to fall several weeks after the closed season period. Results prove, that majority of the squid were born after the closed season period, which had generated greatest abundance of squid immediately after the closed season (November) next year. Taking into consideration a period of about 3-4 weeks in bottom temperature of 15˚C, necessary for the paralarvae to develop and hatch, it is perhaps safe to conclude that majority of eggs were laid during the closed season or shortly afterwards. This supports the notion that the closed season acts as a stabilizing period, during which most of the eggs are laid.

Octopod biodiversity in the area sampled by the Brazilian Scientific Expeditions to Antarctica I - VI (1982-1988)

E.A.R. Marian José[1], Osmar Domaneschi[1]

[1]Laboratório de Malacologia, Instituto de Biociências, Universidade de São Paulo. Rua do Matão, 101 - Travessa 14, 05508-900, São Paulo, SP, Brazil, email: jeduardo_marian@yahoo.com.br, domanesc@ib.usp.br

The Brazilian Scientific Expeditions to Antarctica I-VI (1982-1988) yielded 75 octopods from the Bransfield Strait and the neighborhood of Elephant and South Shetland Islands. The octopods were collected by beam-trawls and otter-trawls at depths between 82 and 412m. Seventy specimens belong to 3 genera and 10 species: *Adelieledone polymorpha* (Robson, 1930), *Pareledone aequipapillae* Allcock, 2005, *P. albimaculata* Allcock, 2005, *P. aurata* Allcock, 2005, *P. charcoti* (Joubin, 1905), *P. cornuta* Allcock, 2005, *P. serperastrata* Allcock, 2005, *P. subtilis* Allcock, 2005, *P.* cf. *turqueti* (Joubin, 1905) and *Benthoctopus* cf. *levis* (Hoyle, 1885). The remaining five specimens belong to an undescribed genus and species ("New genus sp. 17") according to a recently published identification key. The material is representative of the Antarctic Peninsula shallow water octopod fauna. Each species and their respective diagnostic features are briefly characterized and illustrated with photographs. The *P.* cf. *turqueti* specimens showed a considerable range of morphological variation and this species is in need of a taxonomic revision. The specific identification of the papillated *Pareledone* has been based mainly on skin texture; in order to improve the systematics of the genus, a detailed investigation of the internal organs of these species is required.

First observation of brooding and early life cycle stages in the Wunderpus

Volker Miske[1], Johann Kirchhauser[2]

[1]Zoologisches Institut und Museum, Ernst-Moritz-Arndt-Universität Greifswald, Johann-Sebastian-Bach-Str. 11-12, D-17487 Greifswald, Deutschland, volker.miske@teuthis.de

[2]Staatliches Museum für Naturkunde Karlsruhe, Erbprinzenstr. 13, D-76133 Karlsruhe, Deutschland, johann.kirchhauser@smnk.de

One of the most unusual species within the Octopodidae is "*Octopus* sp. 20" or Wunderpus, known only from a few specimens from the tropical Indopacific. It was provisionally named by NORMAN (2000). Up until now, almost nothing was known about its life cycle. A female from the Philippines was observed and documented by film in captivity for 39 days. Differing from findings of NORMAN (2000: 304, 314), this specimen held at 26° Celsius was more active during full daylight than during twilight. Nocturnal activity was never observed. After 14 days it was found having laid small, fertilized eggs. They were carried in about two centimetres long, unbranched strings consisting of approximately 30 eggs each held within the arm crown by suckers instead of attaching the strings to the ceiling of a den. It continued moving around and feeding. This rare brooding strategy in octopodids resembles that of species of the blue-ringed octopus (*Hapalochlaena* spp.). Twenty-three days after spawning first planktonic paralarvae hatched. Three days later all were hatched and the mother died. Hatchlings were not observed feeding and survived for three days. Future morphological studies of the preserved offspring could allow identification of paralarvae of this species in plankton samples.

Effect of temperature on the activity and metabolism of Japanese common squid *(Todarodes pacificus)* paralarvae

S. Miyanaga[1], Y. Sakurai[1]

[1]Graduate School of Fisheries Sciences, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido, Japan 041-8611, email: sacchi@fish.hokudai.ac.jp

The swimming behavior of *Todarodes pacificus* paralarvae was examined at temperatures between 15˚ and 23˚C, which is the known temperature range for normal embryonic development. Paralarvae were reared through artificial fertilization at different temperatures, and those capable of swimming were placed in a 1.5-m-deep cylindrical aquarium for 15-minute observation periods. The swimming ability of paralarvae reared at 20˚ and 22˚C improved markedly at Stage 31, suggesting this is the stage when swimming begins. Paralarvae reared below 18˚C swam poorly at all temperatures after hatching, suggesting that egg masses must be maintained above this temperature for reproduction to be successful. The paralarvae always swam upward, which suggests they will occur at the surface in the field. There was no significant difference in the mantle length, yolk volume or dry weight at each developmental stage in paralarvae reared at 16˚ and 22˚C. Future studies will examine the effects of temperature on the oxygen consumption and swimming speed of hatchings at 22˚C.

Distribution and abundance of early life cephalopods off Portugal based on 20 years of historical data

Ana Moreno[1], Antonina dos Santos[1], Uwe Piatkowski[2], A.Miguel P. Santos[1]

[1]Instituto de Investigação das Pescas e do Mar (IPIMAR), Av. De Brasília, s/n, 1449-006 Lisboa, Portugal, www.iniap.min-agricultura.pt, email: amoreno@ipimar.pt

[2]Leibniz-Institut für Meereswissenschaften (IFM-GEOMAR), Düsternbrooker Weg 20, 24105 Kiel, Germany, www.ifm-geomar.de, email: upiatkowski@ifm-geomar.de

The present study analyses distribution and abundance of early life cephalopods from 20 years of historical data collections (1986 to 2004) off Portugal. Twenty-two taxa were identified, including several oceanic species. Loliginidae, Ommastrephidae, Sepiolidae and the octopod *Octopus vulgaris* were the most abundant groups occurring mainly over the continental shelf. Oceanic species, many of them having their northern limit of distribution off Portugal, concentrated in offshore waters in the southern part of the investigated area. *O. vulgaris* presented several seasonal peaks of abundance. In summer it showed a more offshore distribution than in autumn, when distribution concentrated towards the inner shelf. This pattern relates to the oceanographic regime off the western Iberian Peninsula, which is characterised by summer coastal upwelling, favouring an offshore transport, and by a winter regime of coastal convergence. Loliginidae and Ommastrephidae were more abundant along the northern coast. Sepiolidae presented a patchy distribution likely related to a mixture of different species with diverse distribution patterns. Furthermore, data on vertical distribution is presented, especially for Loliginidae. The distribution patterns of the cephalopod species are discussed in relation to local oceanographic conditions, shelf topography and known spawning sites of adult stocks.

Application of acoustic methods for stock assessment and monitoring of arrow squid *Todarodes sagittatus* off north west African coast.

Hassan Moustahfid[1] , Vladimir V. Laptikhovsky[2] , Alexander P. Malishko[3]

[1]Northeast Fisheries Science Center Fisheries Sampling Branch, 166 Water Street ,Woods Hole, MA 02543 USA. email: Hassan.Moustahfid@noaa.gov

[2]Falkland Islands Government Fisheries Department P. O. Box 598 Stanley, The Falkland Islands.

[3]Atlantic Research Institute of Marine Fisheries and Oceanography (AtlantNIRO). 5 Dm.Donskoj St., Kaliningrad, 236000 Russia.

Acoustic survey of arrow squid *(Todarodes sagittatus)* was carried out in an area off north west African waters with R/V "ATLANTNIRO" using modern hull-mounted split beam transducers. The main objective of this investigation was to assess the application of acoustic survey techniques and compared with other stock assessment methods (trawl method) in order to determine geographic range and to increase precision of the stock assessment of the isolated North West African population of arrow squid. During this investigation aggregations of squid were found in narrow bind a long the shelf edge and slope (300-500 m depths) between south of Moroccan and Mauritanian zones (24°30'N -17°00'N). The population was represented by squids of 4-30 cm ML (mostly immature, modal size 14-18 cm). The center of abundance of squid was found in Cape Blanc area between 20°30' N and 21°20' N, where the catches exceeded 25 tonnes/ nm². In northwest African waters, the high diversity and degree of species mixing are generally not compatible with the restrictive criteria for high quality in situ target strength measurements. During this survey favorable conditions for in situ measurements of target strength (TS) at 38 kHz were rare, except in two occasions, where we been able to identify a significant echoes of squid (small lines) and the mean TS of squid was equal to -42.5 dB for ML=16.7 cm, and -45,7 dB for ML=17.2 cm. This data was two small, to be used for acoustic abundance quantification of squid. TS equation from other similar species was adopted to compute the abundance and to compare the results with the abundance obtained from the trawl data. The comparative analysis between the two methods of acoustic and trawl were both similar on qualitative and quantitative aspects. The distribution pattern of arrow squid were mapped and the total biomass of arrow squid, shared between Morocco and Mauritania (17°-24° N), was estimated of 8.500 tonnes by the acoustic method and 10.500 tonnes by the trawl method.

Are *Idiosepius biserialis* Voss, 1972 and *I. Thailandicus* Chot., Okut. & Chai., 1991 the same species: reproductive behaviour evidence?

Jaruwat Nabhitabhata[1], Jitima Suwanamala[2], Piyama Tasanasuwan[3]

[1]Department of Aquaculture, Faculty of Fisheries, Kasesart University, Bangkok 10900, Thailand

[1]Department of Marine Science, Faculty of Fisheries, Kasetsart University, Bangkok 10900, Thailand

[1]Department of Zoology, Faculty of Science, Kasetsart University, Bangkok 10900, Thailand

Idiosepius biserialis and *I. thailandicus* had been previously described as different species although their prominent difference in morphological characters is only the arrangement of pegs in tentacular-club suckers. The former species inhabits the seagrass bed in the Andaman Sea, Indian Ocean of Thai waters and the latter species inhabits mangrove in the eastern Gulf of Thailand, Pacific Ocean. Observed reproductive behaviour, mating and spawning, of the two species in captivity demonstrated similar patterns and detailed sequences. Copulation was performed using tentacles by male for fixation of spermatophores at the buccal region of female. Behavioural patterns were distinguished based on hovering and adhering positions of each sex. Cross mating between two species was initiated and observed, yielding fertilized eggs which developed to organogenesis stage. Reproductive behaviour of cross pairs was similar to those of normal. This study revealed that the two "species" are not reproductive isolated.

Squid family Ommastrephidae as ecosystem enzymes and integrators

Chingis M. Nigmatullin

Atlantic Research Institute of Marine Fisheries and Oceanography (AtlantNIRO), Donskoj Str. 5, Kaliningrad, 236000 Russia, email: squid@atlant.baltnet.ru

species of ommastrephid squid are widely distributed throughout the Worlds Oceans from Subarctic to Subantarctic. They are "strong interactors" (Paine, 1980) that organize community structure at the consumer levels from II-III to V-VI orders and direct energy and matter flows. During their long daily vertical (up to 1000-2000 meters), ontogenetic latitudinal (up to 1,000-1,800 miles) and bathymetric migrations squids cross through diversity vertical zones, climatic zones and local ecosystems. Hence ommastrephids are an important element in the "rigid framework" of highly mobile predators that integrate local ecosystems into ecosystems of the next higher level, and eventually into the whole ecosystem of the Worlds Oceans. From the standpoint of the rate and the scale of matter and energy transformation per time unit by animals, ommastrephids are the leaders among nektonic animals. Owing to the unique combination of parameters such as very high abundance, biomass (~55 million t), production (~400 million annually), food consumption (individual consumption 6-12% $BWday^{-1}$, ~1,000 million t annually), total and active metabolism, rates of somatic and generative growth, one year life cycle and highly diversified trophic relations, in the Worlds Ocean ecosystems ommastrephids act as peculiar "ecosystem enzymes" that significantly accelerate biogeochemical processes

Fecundity and oocyte stock development in Antarctic squids

Chingis M. Nigmatullin

Atlantic Research Institute of Marine Fisheries and Oceanography (AtlantNIRO), Donskoj Str. 5, Kaliningrad, 236000 Russia, email: squid@atlant.baltnet.ru

Size composition, phases of oocyte development and potential fecundity (PF – total oocyte stock) was examined in 5 species of common Antarctic squids. In 6 immature and maturing *Moroteuthis ingens* females of ML 190-540 mm PF varied between 390-400 thousand oocytes. In 7 immature and maturing *Moroteuthis knipovitchi* females of ML 200-350 mm PF ranged between 90-100 thousand. In 16 immature and maturing *Psychroteuthis glacialis* females of ML 130-315 mm PF values were 10.7-15.6 thousand. In 2 spent *Galiteuthis glacialis* females of ML 420 and 475 mm residual fecundity was 10.6-20.9 thousand, and the estimated PF approximately 40-80 thousand. These 2 squid had only vitelline resorbed oocytes in their ovaries and two ripe eggs of 3.3x2.4-2.5 mm in their oviducts. In 4 immature and maturing *Mesonychoteuthis hamiltoni* females of ML 1780-2350 mm PF was within narrow limits of 4-4.2 million. In all species studied there was a solitary shifting unimodal group during ontogenesis. In the process of protoplasmic growth and the beginning of vitellogenesis a whole stock of oocytes develops synchronously, and in the ovaries of maturing and mature females the protoplasmic oocytes are absent. The results of this study are discussed together with data from another group of cephalopods.

Phylogeny of the mini-maximalist squid, *Idiosepius*

Michele K. Nishiguchi

Department of Biology, New Mexico State University, Box 30001, MSC 3AF, Las Cruces, NM 88003-8001 USA

nish@nmsu.edu

Understanding life history characteristics and how the evolution of particular reproductive strategies may influence speciation has been one of the key interests in ecology. The seven known species of the pygmy squid genus *Idiosepius (I. pygmaeus* Steenstrup, 1881, *I. paradoxus* Ortmann, 1888, *I. picteti* Joubin, 1894, *I. notoides* Berry, 1921, *I. biserialis* Voss, 1962, *I. macrocheir* Voss, 1962, *I. thailandicus* Chotiyaputta, Okutani & Chaitiamvong, 1991) are among the smallest living cephalopods of the world, and are all contained within one family (Cephalopoda: Idiosepiidae). These squids are so unique in that they have been recently named "mini-maximalists". The small adult size (10-18 mm) and the special sedentary adult life history of *Idiosepius* raises questions about life history strategies, such as how much of the biogeography is a consequence of genetic and ecological constraints, as well as whether evolutionary contingencies (i.e., reproductive strategies) have influenced the radiation and speciation of this group of squids. Using both molecular and morphological data, a phylogeny of the species of *Idiosepius* has been used to determine if related species have similar reproductive attributes, and whether patterns of fecundity, and adaptation to various ecological habitats have separated these widely distributed species of squid.

Reproductive biology of purpleback flying squid, *Sthenoteuthis oualaniensis* (Lesson, 1830) in the Andaman Sea

Praulai Nootmorn, Anchalee Yakoh

Andaman Sea Fisheries Research and Development Center, 77 Tumbon Vichit, Maung District, Phuket 83000, Thailand, e-mail:nootmorn@yahoo.com

Purpleback flying squid, *Sthenoteuthis oualaniensis* (Lesson, 1830) were captured by automatic jigging gear during the ASEAN – SEAFDEC program on "Harvesting of Under- Exploited Resource, Phase I: Pelagic fisheries Resources Survey in the Andaman Sea" investigated by M.V.SEAFDEC in November 2004. From a total of 129 squids measurements of ML and weight were taken. Females ranged from 86-197 mm and 19-346 g and males ranged from 103-126 mm and 35-106 g. Length-weight relationship of female and male equal $W = 1.4x10^{-6} ML^{3.6716}$ and $W = 9.99x10^{-8} ML^{4.2631}$. Females occurred more frequently than males in the catch, with 88% of squid being female and ranged from 78.57-100%. Males were also smaller than females. Maturity of squid found that Stage 4 dominated in female and male. In addition, the proportion of mature and immature females was equal but in male can't point out. GSI increased with ML in median size (150-200 ML mm). Size at first maturity of female and male was 98 mm (38 g) and 104 mm (36 g) respectively, which smaller than the estimate as female 150 mm and male 128 mm.

Problems concerning the morphological classification of *Idiosepius*

Sylvia Nürnberger, Janek von Byern, Waltraud Klepal

University of Vienna, Cell Imaging and Ultrastructure Research, 1090 Vienna, Austria

Idiosepiidae is a small taxon represented by a single genus with seven species. Morphologically, the species are characterized by the arrangement of suckers on the club (two or four rows) and by the number of suckers on the ventral arms. The differences between two particular species are marginal: While *Idiosepius thailandicus* bears 3 rows of pegs at the distal portion of tentacle suckers, *Idiosepius biserialis* has a 4-rowed arrangement of pegs. SEM observations on *Idiosepius biserialis* from Moçambique provide new insights into the morphology of these animals and challenge the current classification. Specimen treatment before fixation greatly influences the arrangement of tentacle suckers. Non-anaesthetized animals contract the tentacles during fixation and show the so-far described 2-rowed arrangement, whereas specimens anaesthetized (3% ethanol-seawater (v/v) solution) before fixation relax the club and display a 3- up to 4-rowed arrangement of suckers. Several investigated specimens of *Idiosepius thailandicus* possess, like *Idiosepius biserialis,* also a 4-rowed arrangement, making the classification of *Idiosepius thailandicus* as a separate species questionable. These observations suggest that the current systematic key for this genus is untenable and needs to be revised.

Malformations on tentacles of *Idiosepius paradoxus*

Sylvia Nürnberger, Janek von Byern, Waltraud Klepal

University of Vienna, Cell Imaging and Ultrastructure Research, 1090 Vienna, Austria

Tentacle suckers are conservative structures in cephalopod anatomy and have a fundamental function in nutrition. Nevertheless, non-lethal malformations occur in several taxa of cephalopods. In *Idiosepius paradoxus,* abnormal growth was found in the tentacles and its suckers. In one female, an extra "arm-like" structure branched basally from the right tentacle. This appendix is smaller than the tentacle, with suckers arranged irregularly or in pairs. One male developed only one sucker on the right and no suckers on the left tentacle. Even residual structures such as sucker shafts or injuries were not visible. This malformation apparently did not influence prey capture: it may have been compensated behaviourally. In some cases, both sexes have half-sized suckers in the middle part of the tentacle. Up to now, regeneration of suckers has not been observed on tentacles and arms. The incomplete suckers are therefore either malformations or residuals of atrophy. The malformations found in sexually mature specimens (determined by body size and fully developed suckers on arms and hectocotylus) suggest that these structures did not affect prey capture.

Development of a coastal habitat resources information system for Queensland (1998-2005)

Len Olyott, Malcolm Dunning, Grant Hansen, Brooke Young

Department of Primary Industries and Fisheries, Queensland, GPO Box 46, Brisbane, Qld, 4001, Australia,

http://www.dpi.qld.gov.au/fishweb/, malcolm.dunning@dpi.qld.gov.au

The Coastal Habitat Resources Information System (CHRIS) was established by the Department of Primary Industries & Fisheries, Queensland as a spatial information system (GIS) to integrate existing fisheries data with baseline tenure and topographic data to allow monitoring of the status and changes in fisheries habitats and resources. CHRIS was also designed to establish appropriate links to commercial and recreational fisheries catch and effort data and through appropriate user interfaces and network links to allow improved access to fisheries data by fisheries managers, researchers, the fishing industries and the public.

The Pholidoteuthidae Adam, 1950 (Cephalopoda): a redescription of *Pholidoteuthis massyae* (Pfeffer, 1912), and evaluation of relationships with other dermal-scale-possessing Teuthoidea

S. O'Shea[1], G. Jackson[2], K.S. Bolstad[1]

[1]Earth and Oceanic Sciences Research Institute, Auckland University of Technology, Private Bag 92006 Auckland 1020, New Zealand. soshea@aut.ac.nz, kbolstad@aut.ac.nz

[2]University of Tasmania, Institute of Antarctic and Southern Ocean Studies, Private Bag 77, Hobart, Tasmania, Australia. George.Jackson@utas.edu.au

Squid of the genus *Pholidoteuthis* are characterised by unusual, close-set dermal cushions ("scales") on the mantle. Despite frequent reference to this genus, considerable systematic confusion surrounds usage of both the generic name — probably erected prematurely, given the status of another genus, *Tetronychoteuthis* (equally applied to species with the same systematic characters) — and species attributed to it. The synonymy and ontogenetic morphology of *Pholidoteuthis massyae* (Pfeffer, 1912), herein determined as the senior synonym of *P. boschmai* Adam, 1950, are reported. The relationship between this species and others referred to *Tetronychoteuthis, Lepidoteuthis,* the Pholidoteuthidae Adam, 1950, the Lepidoteuthidae Pfeffer, 1912, and the Octopoteuthidae Berry, 1912, is also discussed. A conjectural account of the mechanics of mating is provided based on the nature of spermatophore insertion in the female mantle, and terminal modifications to the male genital apparatus.

Parasites and cephalopod fisheries uncertainty: towards a waterfall model understanding

S. Pascual[1], A.F. González[1], A. Guerra[1]

[1] Ecobiomar, Instituto de Investigaciones Marinas (CSIC). Eduardo Cabello 6, 36208 Vigo. Spain, www.iim.csic.es, email: afg@iim.csic.es

The issue of uncertainty from a biological perspective should consider the multiple sources of variability, which in fact makes the world's fisheries a stochastic problem. Herein, we provide a review of the effects of parasites as categorical predictors of uncertainty in cephalopod populations. Recent work provides evidences of the role of parasitic diseases as contributing categorical predictors of cephalopod growth variability, from the molecular to population levels. Additionally, parasites impair the well-being of cephalopod populations by diminishing the absorption nutrient capabilities of infected animals, by mechanical lysing of large areas of functional tissues, or by depleting energy stores allocated at the haemolymph or different tissues. The costs of harbouring parasites have obvious ecological consequences for the exploited stock, although these are not as well understood as many other sources of stock uncertainty. The parameters needed to detect further costs of harbouring parasites under different environmental scenarios require controlled quantitative experimental designs that incorporate a hierarchical thinking inclined towards interactions. This "waterfall" model understanding will allow improving our knowledge of the importance of parasites as a source of cephalopod fisheries uncertainty. Once this is recognized, the epidemiological information of infected stocks should be incorporated into bioeconomical models of fishery management.

Addressing spatial management issues of squid with acoustic telemetry

Gretta T Pecl[1], Sean R Tracey[2], Jayson M Semmens[3], George D Jackson[4]

[1], Marine Research Laboratories, Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, Private Bag 49, Tasmania, Australia, 7001, http://www.utas.edu.au/tafi/Profiles_MRL/TAFI_Gretta_Pecl.htm, Gretta.Pecl@utas.edu.au.

[2], Marine Research Laboratories, Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, Private Bag 49, Tasmania, Australia, 7001, Sean.Tracey@utas.edu.au

[3], Marine Research Laboratories, Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, Private Bag 49, Tasmania, Australia, 7001, Jayson.Semmens@utas.edu.au

[4], Institute of Antarctic and Southern Ocean Studies, University of Tasmania, Private Bag 77, Tasmania, Australia, 7001, George.Jackson@utas.edu.au

Management concerns about escalating catch and effort for southern calamary in Tasmania, led to the introduction of three-month closures of two main regions, separated by 25-35km, where calamary aggregate to spawn and are targeted by the fishery. This study assessed the relationship between these areas, and the degree of protection that closures may provide to spawners. Eighty-three moored VR2 acoustic receivers detected detailed movements of 46 acoustically tagged squid; each receiver recorded date, time and unique ID of tagged squid swimming within 300-500m. VR2's were placed along boundariesencl of Great Oyster Bay and Mercury Passage, across smaller bays within these areas, and on individual seagrass beds. Over 118,000 individual detection events were obtained, with data clearly demonstrating that individuals spawn over several months, travelling 100's of km within the spawning areas during this time. Although most squid were travelling minimum distances much greater than the 25-35km gap between Great Oyster Bay and Mercury Passage, movement between these two areas was not detected. Squid were detected on closed area boundaries, however, most were detected again on other receivers within the closed area, indicating that although squid had moved within boundary vicinities, they had not actually left the closed, and therefore protected area.

Comparative study of bacteria diversity and bioaccumulation of trace elements in the excretory organs of *Nautilus.*

M. Pernice[1], J. Boucher, P. Joannot, R. Boucher-Rodoni

UMR 5178, Muséum National D'Histoire Naturelle, CP51, 55 Rue Buffon, Paris 75005, France, email: pernice@mnhn.fr

Cephalopods, Nautiloids and Coleoids, are known to concentrate trace elements in various organs, the excretory organs and the digestive gland playing a key role in the metabolism of metals. Among Nautiloids, *Nautilus macromphalus* is endemic of New Caledonia, where the seawater is rich in elements such as Co, Cr, Fe and Ni, due to natural erosion and mining activity. A metal enrichment of the New Caledonian coral reef food webs has been described in several species. Cephalopods appear to be able to grow and reproduce with very high metal concentrations, with their detoxification strategy involving storage mechanisms for these elements. Nautilus is a scavenger, at the top of the food web. Trace elements appear to concentrate in their digestive gland and the excretory organs (Bustamante et al., 2000). The excretory organs also harbour a diverse bacteria population. We compare the trace element concentration in the excretory organs of two species: *N. macromphalus* from trace element rich areas and *N. pompilius* inhabiting areas away from mining soils. We hypothesize a relation between metals concentration and bacteria diversity.

Cephalopod diversity along the northern mid-Atlantic Ridge

Uwe Piatkowski[1], Michael Vecchione[2], Richard E. Young[3]

[1]Leibniz-Institut für Meereswissenschaften (IFM-GEOMAR), Düsternbrooker Weg 20, 24105 Kiel, Germany, www.ifm-geomar.de, upiatkowski@ifm-geomar.de

[2]National Marine Fisheries Service, Systematics Laboratory, National Museum of Natural History, Washington, D.C. 20560, USA, vecchiom@si.edu

[3]Department of Oceanography, University of Hawaii, Honolulu, Hawaii 96822, USA, ryoung@hawaii.edu

From 4 June to 5 August 2004 the G.O. Sars expedition along the northern mid-Atlantic Ridge was a major field study initiative under the MAR-ECO project (www.mar-eco.no), a field project under the Census of Marine Life. The multidisciplinary studies covered an area between approximately 42°N to 60°N. In the course of the expedition, an extensive sampling programme for pelagic and demersal nekton was performed, using a suite of research and commercial trawls of different sizes ranging from 1 to 10,000 m^2 net opening. Sampling covered discrete layers of the water column, partly down close to the seafloor. The net sampling was complemented by ROV observations to a depth of 2,500 m. The sampling yielded a total of 1,261 cephalopods, belonging to 29 families, and at least two new species. Here we report on cephalopod species composition, geographical distribution patterns, size distribution and assemblage structure. Cephalopod diversity increased significantly from north to south. The squid genera *Gonatus* and *Mastigoteuthis* were the most abundant cephalopods in terms of numbers. The data constitute one of the biggest cephalopod collections ever made along the mid-Atlantic Ridge and provide new insights into the cephalopod deep-sea fauna of the Atlantic Ocean.

First Cytochrome *C* Oxidase I and 16S RNA genes partial sequences and phylogenetic relationships in the hooked giant squid *Taningia danae*

Isabel Rey[1], Oscar Soriano[2], Beatriz A. Dorda[3], Ángel F. Gonzalez[4], Francisco Rocha[4], Ángel Guerra[6]

[1]Museo Nacional de Ciencias Naturales (CSIC. J. Gutiérrez Abascal 2, 28006 Madrid. Spain. email address: mcnrf3g@mncn.csic.es

[2]Museo Nacional de Ciencias Naturales (CSIC. J. Gutiérrez Abascal 2, 28006 Madrid. Spain. email address: mcnh149@mncn.csic.es

[3]ECOBIOMAR. Instituto de Investigaciones Marinas (CSIC). Eduardo Cabello 6, 36208 Vigo, Spain. email address: afg@iim.csic.es

[4]ECOBIOMAR. Instituto de Investigaciones Marinas (CSIC). Eduardo Cabello 6, 36208 Vigo, Spain. email address: frocha@iim.csic.es

[6]ECOBIOMAR. Instituto de Investigaciones Marinas (CSIC). Eduardo Cabello 6, 36208 Vigo, Spain. email address: brc1@iim.csic.es

We present for the first time sequences of two genes in a rarely encountered squid (*Taningia danae* Joubin, 1931). The COI partial sequence consists of 484 bp, which was deposited in the database of GenBank with the Accession Number AY393902. The 16S partial sequence consists of 534 bp and has been included in GenBank database with the AN: AY393901. Since beaks, with some adhered muscles and eye lenses of identified species, are often preserved separately in ethanol or dry, whilst the whole animal is fixed in formalin, the use of these structures would allow comparative studies employing specimens actually preserved in collections worldwide. Therefore, the technique here proposed for extracting DNA from beaks and eye lenses might ensure good DNA quality for evolutionary studies from extant specimens. Preliminary phylogenetic relationships of *T. danae* are also presented and discussed.

Determining the influence of bottom turbidity and upwelling on chokka squid spawning behaviour

M.J. Roberts[1], N. Downey

[1]Marine Coastal Management, Private Bag X2, Roggebaai, Cape Town, Western Cape 8012, South Africa, email: squid@metroweb.co.za

Several studies suggest that the environment influences the successful formation of inshore spawning aggregations, and hence chokka squid catches. Acoustic tag telemetry offers a means to determine the behavioural response of spawners to changes in the environment. In November 2004, six *Vemco* VR2 hydrophone instruments were moored in Kromme Bay (St Francis Bay) in a circle around an active squid spawning aggregation. A seventh instrument was placed in the centre. Twelve squid were caught on jigs and tagged with V8 acoustic pressure telemetry tags. All animals released were followed by SCUBA divers using video to verify successful re-integration of the animal into the spawning aggregation. Data showed that only one animal (male) stayed in the area throughout the 13 day experiment, albeit, intermittently. All other tagged animals had disappeared within 4 days. The squid showed a mixed diurnal presence/absence pattern in the spawning area with some animals having moved off the egg beds during the day and others staying throughout the nights, in contradiction with the findings of an earlier telemetry experiment. Pressure sensor data showed that both males and females stayed persistently near the seabed during the day, regularly making excursions to the seabed. At night this pattern was broken with common activity higher up in the water column. CTD and thermistor data indicated the occurrence of an upwelling event, four days into the experiment, during which those squid present disappeared, with one male returning after the upwelling event.

Morphometric and genetic variation of red octopus *(Enteroctopus megalocyathus)* between Pacific and Atlantic populations in South America

Francisco Rocha[1], Consuelo Hermosilla[2], Jorge Toro[2]

[1].Ecobiomar, Instituto de Investigaciones Marinas (CSIC), Eduardo Cabello 6, 36208 Vigo, Spain, email: frocha@iim.csic.es

[2]. Facultad de Ciencias, Universidad Austral de Chile, Valdivia, Chile, email: cheluna@yahoo.com, jtoro@uach.cl

Specimens of red octopus, *Enteroctopus megalocyathus*, from Hueihue and Quellón ports (Chiloé Island, South Chile), and from Bustamante and Cerro Avanzado localities (South Argentina coast) were analysed using morphometric and genetic methodologies. Discriminant analysis using soft and hard structures successfully distinguishes between both Chilean and Argentinean populations (Wilks Lambda 0.134; $p < 0.0001$: Press's Q 117.233; $p < 0.00001$). However, Random Amplified Polymorphic DNA (RAPD) analysis comparing all samples revealed high genetic diversity (0.230-0.243) and high gene flow between the populations ($Nm = 5.173$). Also, both genetic differentiation and FST estimations indicate low genetic divergence between Chilean and Argentinean populations. An analysis of variance corroborates the previous results showing that intrapopulation genetic variation (88%) explained more differences between samples that genetic variation among populations (12%). Results suggest that *E. megalocyathus* specimens of both Pacific and Atlantic South America coast constitute a unique population.

Reproductive potential changes of *Octopus vulgaris* in Galicia (NW Spain)

Francisco Rocha[1], María del Pilar Sieiro[1], Carmen Piñeiro[1], Santiago Aubourg[1], Ángel F. González[1], Ángel Guerra[1]

[1]Instituto de Investigaciones Marinas (CSIC), Eduardo Cabello 6, 36208 Vigo, Spain,
email: frocha@iim.csic.es, mpsieiro@iim.csic.es, cpineiro@iim.csic.es, saubourg@iim.csic.es, afg@iim.csic.es, brc1@iim.csic.es

The aim of this study is the evaluation of changes in *Octopus vulgaris* reproductive potential after the Prestige oil spill occurred in November 2002 in the North West Iberian coast. Specimens of two affected areas and one non-affected control area were sampled during 2004 and 2005. Potential fecundity of mature females and males were estimated. Potential fecundity during 2004 significantly decreased throughout the year in both, males and females. Specimens hatched before the Prestige event showed a higher fecundity potential than those hatched after the oil spill. Comparisons between specimens obtained from affected and non-affected areas showed that female reproductive potential slightly increased in the affected ones. No significant differences were found, however, in Gonad-Somatic, Hayashi and Condition indexes when affected and non-affected areas were compared. The possible relationship between these reproductive potential changes and hydrocarbon pollution is discussed.

Life history of the giant squid *Architeuthis* as revealed from stable isotope and trace elements signatures recorded in its beak.

Alejandro Rodríguez-Navarro[1], Ángel Guerra[2], Christopher S. Romanek[3], Francisco Rocha[2], Ángel F. González[2]

[1]Instituto Andaluz de Ciencias de la Tierra, CSIC-Universidad de Granada, Granada, Spain,
email: anava@ugr.es

[2]Ecobiomar, Instituto de Investigaciones Marinas (CSIC), Vigo Spain,
email: brc1@iim.csic.es, frocha@iim.csic.es, afg@iim.csic.es

[3]Department of Geology. University of Georgia. Athens, GA 30602, USA and
Savannah River Ecology Laboratory Drawer E, Aiken, SC 29802, USA, email: romanek@srel.edu

Stable isotope and trace element analyses of the beak, a chitinous structure that grows by accretion, of giant squid *Architeuthis* sp. revealed interesting information about its life history. The $\delta^{15}N$ record suggests that early in the life of the squid there was an ontogenetic change in its diet from smaller prey lower in the food web to larger prey higher in the food web. These data support that there are strong similarities in the feeding behaviour of the giant squid and its smaller relatives. From the cyclicity of the nitrogen isotope record, probably associated with seasonality in plankton production, it was possible to estimate the age of the studied squid to be at least 2 years old. The constant carbon isotopic composition suggests a sedentary behaviour at least in adulthood. Trace element (P and Se) profiles in the beak suggested what could be a gradual descent to deeper waters during the life of the giant squid. Finally, stable isotope and trace elements records stored in the beak could give us clues about where to locate the habitat of these elusive creatures.

Estimated winter spawning areas of Japanese common squid, *Todarodes pacificus* in the East China Sea

Kazuaki Sakai[1], Ken Mori[2], Sachi Miyanaga[1], Jun Yamamoto[3], Yasunori Sakurai[1]

[1]Graduate School of Fisheries Sciences, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido 041-8611 Japan, http://www.fish.hokudai.ac.jp/, kaz-s@fish.hokudai.ac.jp

[2]Hokkaido National Fisheries Research Institute, 116 Katsurakoi, Kushiro, Hokkaido 085-0802 Japan http://www.hnf.affrc.go.jp/, moriken@fra.affrc.go.jp

[3]Field Science Center for Northern Biosphere, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido 041-8611 Japan, http://www.hokudai.ac.jp/fsc/, yamaj@fish.hokudai.ac.jp

Information from laboratory studies and paralarval surveys were used to estimate the winter spawning areas of the Japanese common squid *(Todarodes pacificus)*. *Todarodes pacificus* comprises three seasonal spawning groups: autumn, winter and summer. The autumn and winter groups have the largest biomass, and annual catches of the winter group fluctuate widely. In short-lived squids, recruitment success most likely depends on the physical and biological environments at the spawning and nursery grounds. Results from laboratory studies suggest that the hatching success rate from egg masses is high at 15-23˚C and where the mixed layer depth is shallower than the bottom depth, and that hatchlings ascend to the surface at 18-23˚C (see Miyanaga et al. abstract). Paralarvae were colleted in the East China Sea in February during 2001-03. Hatchlings (mantle length < 1 mm) occurred mainly in offshore areas southwest of Kyushu Island, with a few occurring in inshore areas off the Ryukyu Islands. The estimated spawning areas occurred along the continental edge off Kyushu Island and the Ryukyu Islands. Hatchlings are thought to be transported northeastward by the Kuroshio to nursery areas along the continental edge.

Temporal and spatial analysis on the correlation between SST and stock indices of the squid *Illex argentinus*

Sakai, Mitsuo[1], Takaya Namba[2], Norma E. Brunetti[3], Marcela Ivanovic[3]

[1]National Research Institute of Far Seas Fisheries, Orido 5-7-1, Shimizu-ku, Shizuoka-shi 424-8633, JAPAN

[2]Fisheries & Aquaculture International Co. Ltd.

[3]Institute Nacional de Investigacion y Desarrollo Pesquero

Stock size of the squid *Illex argentinus*, especially the south Patagonian stock, has suddenly decreased since 2000. The cause of the depletion is unknown, but recent remote-sensed studies indicated that the oceanographic condition would affect the recruitment success in the inferred hatching area of the squid. According to the hypothesis, we examined the correlation between sea surface temperature (SST) and stock indices of the squid in the following fishing season. Each averaged 1˚-gridded SST by each month was obtained from 1985 to 2003 in the area 25 to 55˚S/45-70˚W through NOAA-Pathfinder-5 (4km resolution). CPUE, catch per unit effort (ton per day), of Japanese jigging boats was principally used as an index of the squid stock. High positive correlations were observed in several areas of the Argentine continental shelf in June, but no correlation was observed in the inferred hatching area of the squid. From the result on the seasonal and spatial distribution of the correlation, we discuss the annual fluctuation of the squid stock.

Modelling catch and climatic variables in *Loligo vulgaris* and *Sepia officinalis* fisheries in two Spanish Mediterranean ports.

P. Sanchez[1], M. Gonzalez[2]

[1]Institut de Ciencies del Mar-CSIC, P. Maritim de la Barceloneta 37-45, 08003 Barcelona, Spain.
email: pilar@icm.csic.es

[2]Centro Oceanografico de Murcia-IEO, Varadero 1, 30740 San Pedro del Pinatar, Spain

A General Linear Model (GLM) was applied to understand abundance variation in *Loligo vulgaris* and *Sepia officinalis.* The relationships between monthly catches obtained by the trawl fleet of Barcelona and Santa Pola (NW Mediterranean, Spain) and climatic variables (sea surface temperature, rainfall rates and volume of rain) were analysed. The results showed that the model fitted to the Santa Pola *Loligo vulgaris* data explained 68.57% of the deviance and the month and year were important in explaining variability in catches. In *Loligo vulgaris* from Barcelona, 71.11% of the deviance was explained by the model and also in this case month was the most important variable. On the other hand, the models fitted to the *Sepia officinalis* data series could explain 40.68 % in the case of Barcelona, and 67.65% for Santa Pola data. In both cases temperature was the most important variable.

Biology and population dynamics of *Loligo vulgaris* in Catalan waters (NW Mediterranean)

P. Sanchez[1], M. Baeta[2], R. Allue[3]

[1]Institut de Ciencies del Mar-CSIC, P. Maritim de la Barceloneta 37-45, 08003 Barcelona Spain,
email: pilar@icm.csic.es

[2]ECOPROGRES,S.L., Llull 109, 08005 Barcelona Spain

[3]DARP, Generalitat de Catalunya, Gran Via de les Corts Catalanes 612-614, 08007 Barcelona

Population structure and reproductive patterns of *Loligo vulgaris* in Catalan waters were analysed from biological monthly samples of commercial catches landed in the Catalan coast from October 2003 to September 2004. *L. vulgaris* spawn throughout the year, but the period of more intensive spawning extends from December to March, with egg-masses also found throughout the year. The period with the biggest proportion of recruits (>110 mm) was from August to November. Males were more precocious than females. The smallest mature male was 140 mm ML and the smallest female measured 160 mm ML. Sex ratio was variable throughout the year. The exponents of males and females mantle length- total weight and mantle length-eviscerated weight relationships were 2.45 and 2.44 and 2.53 and 2.40 respectively.

The life cycle of the Japanese pygmy squid, *Idiosepius paradoxus.*

Noriyosi Sato[1], Takasi Kasugai[2], Hiroyuki Munehara[1]

[1]Usujiri Fisheries Station, Field Science Center for Northern Biosphere, Hokkaido University, 152 Usujiri, Hakodate, Hokkaido 041-1613, Japan. E-mail: norico@fish.hokudai.ac.jp

[2]Port of Nagoya Public Aquarium, Nagoya, 455-0033, Japan. E-mail: t-kasugai@nagoyaminato.or.jp

The life cycle of the Japanese pygmy squid, *Idiosepius paradoxus,* was investigated based on analyses of growth and age. Ten specimens of each sex collected monthly with a small drag net (mesh of 1.5 mm) in Ise Bay (central Honshu Island) were examined. The dorsal mantle length (ML) and wet body weight (BW) of each specimen were measured after preservation in 100% ethanol, and statolith increments were counted. The average ML and BW of males and females increased from November (ML: 5.3mm and 7.1mm, BW: 0.04g and 0.08g) to April (ML: 9.9mm and 13.3mm, BW: 0.10g and 0.23g). The average age also increased from about 60 days in November to about 170 days in April. The age composition each month was unimodal, and the maximum daily age was 183 days, which support previous reports that *I. paradoxus* has a 6-month life span.

Metals and metalloids in *Octopus vulgaris* tissues

Sónia Seixas[1], Graham Pierce[2]

[1]Universidade Aberta, Rua Escola Politécnica, 147,1269-001 Lisboa, Portugal, sonia@univ-ab.pt

[2]University of Aberdeen, Department of Zoology, Tillydrone Avenue, Aberdeen AB24 2TZ, Scotland. United Kingdom, g.j.pierce@abdn.ac.uk

We quantified levels of 17 metals and metaloids (potassium, calcium, titanium, vanadium, chromium, manganese, iron, cobalt, nickel, cooper, zinc, arsenic, selenium, rubidium, strontium, molybdenum and lead) in several tissues (digestive gland, branchial hearts, gills, mantle and arms) of common octopus *(Octopus vulgaris)* at three locations along the Portuguese coast, during the two seasons of the year (autumn and spring). The technique used in these determinations was Particle Induction X-ray Emission (PIXE). We carried out a multivariate analysis of patterns of variation in metal concentration and relationships between levels of different metals to studied the behaviour of elements between them and with explanatory variables such as weight, maturation state, sex, localities and seasons.

Species composition and occurrence of cephalopods in the South China Sea in spring 1986

G.A. Shevtsov, O.N. Katugin

Pacific Research Fisheries Centre (TINRO-Centre), 4 Shevchenko alley, Vladivostok 690 950, Russia,
email: okatugin@mail.ru, katugin@tinro.ru

Cephalopods were collected in midwater and bottom nets (with 10 mm mesh size in the cod-end) in the South China Sea offshore areas (Herald Bank) during trawl survey in March-April 1986. Tows were made in a depth range 0-680 m, and temperature range 6.4-27.9ºC. Up to 1,000 individual cephalopods were caught per hour trawling. Fifteen species of cephalopods from eight families were identified from trawl catches: Sepiolidae *(Iridoteuthis iris)*, Enoploteuthidae *(Enoploteuthis leptura magnoceani, Abralia armata, Abralia astrosticta, Abralia andamanica,* and *Abraliopsis* sp.), Ancistrocheiridae (*Ancistrocheirus lesueurii*), Pyroteuthidae *(Pyroteuthis margaritifera)*, Onychoteuthidae *(Onychoteuthis banksii)*, Histioteuthidae *(Histioteuthis oceani)*, Ommastrephidae *(Todaropsis eblanae, Nototodarus hawaiiensis, Sthenoteuthis oualaniensis,* and *Ornithoteuthis volatilis)*, and Cranchiidae (*Liocranchia reinhardti*). All captured animals were adults. *I.iris* and enoploteuthids were represented by prespawning individuals (females were with ripe eggs and males with mature spermatophores). The following species were recorded in the study area for the first time: *I.iris, A.astrosticta, E.leptura magnoceani, P.margaritifera* and *H.oceani.*

Molecular species identification and morphology of gonatid squid paralarvae from the north Pacific

Saya Shimura[1], Syuiti Abe[1], John R. Bower[2], Tsunemi Kubodera[3], Yasunori Sakurai[1]

[1]Graduate School of Fisheries Sciences, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido, Japan 041-8611, E-mail: shimura@fish.hokudai.ac.jp

[2]Northern Biosphere Field Science Center, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido, Japan 041-8611

[2]National Science Museum, 3-23-1 Hyakunin-cho, Shinjuku Tokyo, Japan 169-0073

This poster describes a method we are now using to identify gonatid squid paralarvae from the North Pacific. At least 16 gonatid species inhabit this region, where they are an important prey of many nekton. However studies of their paralarvae are hampered by identification uncertainties, particularly for specimens smaller than 5 mm in mantle length. Paralarval specimens were collected aboard the *Oshoro Maru* and *Kaiyo Maru* during four cruises in 2003-04 and divided into morphotypes based on physical characteristics (relative arm lengths, chromatophore patterns, and degree of head withdrawal into the mantle cavity). Polymerase chain reaction (PCR) was used to amplify the mitochondrial cytochrome oxidase I (COI) gene from each morphotype, and the PCR products were sequenced. These sequence data were then compared with data from adults to identify the paralarval morphotypes. Morphotypes identified to date include *Berryteuthis anonychus, Gonatopsis borealis* and three undetermined *Gonatopsis* spp. When we complete this study, we will construct an identification key to the newly hatched stages of the gonatids for use in future field studies.

Yolk utilization, water, organic and inorganic content *of Octopus vulgaris* eggs during embryonic development

Lisiane Silva, Erica Vidal*

Universidade Federal Do Rio Grande

To evaluate yolk utilization, water, organic and inorganic content of *Octopus vulgaris* eggs during embryonic development wet and dry weights (WW, DW), ash-free dry weight (AFDW) and ash weight (AW), were obtained from samples of 100-150 eggs (n=1650), collected on odd days during the 25 days of development at 24±1°C. Measurements of the yolk sac made by image analysis were converted into volume and then into weights (YW). Mean WW and DW at Day 1 were 1.1 mg and 0.37 mg respectively. While DW remained fairly constant throughout the development, WW increased 68% reaching 1.81 mg on Day 21. Mean YW at the Day 1 was 0.50 mg, representing 46% of WW and showing a gradual decrease during organogenesis (0.24 mg at Day 21). The highest percent levels of AFDW and AW in relation to DW were of 86% and 11% respectively. The results showed that mean WW of the eggs increased 68% due to the absorption of water by the embryo, nevertheless, the loss in biomass was low, indicating that yolk was efficiently converted into body mass at the chosen incubation temperature. These results are important to understand the factors involved in the production of paralarvae with more yolk at hatching and higher survival potential for culturing.

Spatial and temporal patterns of squid personality traits

David L. Sinn, Natalie A. Moltschaniwskyj

School of Aquaculture, Tasmanian Institute of Fisheries and Aquaculture, University of Tasmania

There has been recent interest in the ecological significance of a number of major axes of behavioural variation in animals, referred to alternatively as 'animal personality traits' or 'behavioural syndromes'. These axes represent consistent inter-individual differences in behavioural styles or tendencies, and studies have begun to show their importance in explaining a number of life history variables, including growth, body size, and dispersal. Thus, animal personality traits may have significant explanatory power in understanding how individuals relate to populations. Despite this, there is little information on the spatiotemporal patterns of variation in these behavioural axes in wild populations of animals. This study examined patterns of means and frequency distributions of personality phenotypes in squid in two separate populations across three years. Population densities, sex-ratios, and body sizes were also documented in order to help explain any patterns in the data. Means and frequency distributions of phenotypes were site and year specific; however, there were no clear relationships between patterns in the behavioural data and the biological and ecological characteristics of the populations. The mechanism of population mean-change in personality traits through time, however, did differ across populations. Results are discussed in terms of frequency- and density-dependent selection regimes on behavioural strategies and the maintenance of personality trait variation in squid.

A comparison of seasonal patterns of investment in reproductive and somatic tissues in *Loligo* squid across several European stocks

J.M. Smith[1], G.J. Pierce[2], A.F. Zuur[1]

[1]University of Aberdeen, Tillydrone Avenue, Aberdeen AB24 2TZ, UK [tel: +44 1224 272866, fax: +44 1224 272396, e-mail: jennifer.smith@abdn.ac.uk

[2]Highland Statistics Ltd., 6 Laverock Road, Newburgh, Aberdeenshire AB41 6FN, UK, email: highstat@highstat.com

Morphometric and reproductive data of *Loligo forbesi* and *Loligo vulgaris* samples collected from ports in Portugal during 1990-92 (Azores, Faro and Nazaré) and Spain during 1991-92 (Barcelona and Vigo) were analysed to describe patterns of reproductive and somatic investment through comparison of large numbers of individuals at different (post recruit) life-cycle stages. Generalised additive models (GAMs) were used to permit simultaneous evaluation of multiple explanatory variables for non-linear growth relationships. The models produced were then cross-compared with those previously obtained from analysis of Scotland (UK) data from 1989-91 to evaluate geographical variation between the North Sea, Atlantic Ocean and the Mediterranean Sea. We ask (a) what controls the onset of maturation – season, size, nutritional state, external conditions or some combination of these factors; (b) does somatic investment continue, stop or is energy stored in the mantle mobilised to grow gonads; (c) how do the sexes differ in terms of the time course and cost of reproductive investment?

The socio-economics and catch and effort data of a small-scale, directed squid fishery in the Moray Firth, Scotland (UK)

J.M. Smith, G.J. Pierce

University of Aberdeen, Tillydrone Avenue, Aberdeen AB24 2TZ, UK, e-mail: jennifer.smith@abdn.ac.uk

The history of the small-scale, directed squid fishery in the Moray Firth, Scotland, (UK) was reviewed. This fishery targets recruits appearing close inshore. Interviews with fishermen were conducted in the ports of Fraserburg, Burghead and Buckie during the fall of 2005 to obtain a greater understanding of the importance of the squid fishery, with the aim to obtain a picture of (a) estimation of unreported catch and effort in the fishery, (b) percent contribution of the directed fishery to total UK cephalopod landings, (c) economic value of cephalopod landings and (d) importance of the cephalopod fishery to the fishermen as an employment opportunity and source of income. Analysis of fishing effort and potential catch was carried out using the Gómez-Munoz model. Recent trends in landings, fishing effort, fleet size and employment were analysed using production functions to provide an indication of the sustainability of the fishery.

A case-study of the socio-economics and catch and effort data of a small-scale, artisanal *Loligo* fishery in the northern Aegean Sea (Greece)

J.M. Smith, G.J. Pierce

University of Aberdeen, Tillydrone Avenue, Aberdeen AB24 2TZ, UK [tel: +44 1224 272866, fax: +44 1224 272396, e-mail: jennifer.smith@abdn.ac.uk

Interviews with fishermen and cephalopod processing factory managers were conducted to obtain a greater understanding of the importance of both directed and non-directed artisanal *Loligo* squid fisheries in the ports of Kavala, Keramoti, and Thassos Island (Kavala Prefecture), Greece, with the aim to obtain a picture of (a) estimation of unreported catch and effort in the fishery, (b) percent contribution of the artisanal fishery to total cephalopod landings, (c) economic value of artisanal landings and (d) importance of the cephalopod fishery to the fishermen as an employment opportunity and source of income.

Selectivity in octopus *(O. vulgaris)* clay pots fisheries (South of Spain)

Sobrino Yraola, Dr Ignacio

Instituto Español De Oceanografía, Edif. CAYTMAR, PUERTO REAL CÁDIZ 11510, Campus Universitario Rio S Pedro, SPAIN, ignacio.sobrino@cd.ieo.es

In the south of Spain an important artisanal fishery has been developed in two different areas. The Spanish south Atlantic Region (Gulf of Cadiz) that covers the area from Portugal to Gibraltar Straits in Atlantic waters and the south Mediterranean Region (Gibraltar strait to Almeria). This artisanal fishery of cephalopods is characterised by its multi-gear nature which encompasses a great variety of fishing gear mainly focused on the octopus, among which traps, clay-pots ("alcatruces"), "chivos", and "pulperas" hand-jigs are worth mentioning. The clay and plastic pot are a very simple type of trap, consisting of a vase-like clay pot or plastic pot with a small hole in its bottom. This gear profits from the need for shelter by certain species as the octopus; hence, not needing any type of bait to attract the prey. The clay pots are rigged to long lines, with a separation between them of 10 m, arranged in different manners. They can be placed forming a labyrinth of lines containing 50-70 clay pots, or placed in parallel lines forming lanes composed of a variable number of pots, but generally ranging from 150-200 pots. Like the traps, the number of lines varies depending on the capacity of the vessel. The maximum number of pots per vessel is limited to 1000 units. Over two years we have developed a selectivity experiment in both areas (Gulf of Cadiz and South Mediterranean), using line-pots of different material (clay and plastic), sizes and forms. In this poster we present the results obtained during the first year of field work.

Variability in the arrow squid *(Nototodarus gouldi)* jig fishery in southern Australia: do environmental conditions influence annual abundance?

Kate E. Stark

IASOS & TAFI, University of Tasmania, Private Bag 77 Hobart Tasmania, 7001, kate.stark@utas.edu.au

N. gouldi are widespread in southern Australian shelf waters and support the largest squid fishery in the country. Typical of many squid fisheries around the world, catches and catch rates fluctuate widely from year to year. This study investigated the influence of environmental conditions on the interannual variability of *N. gouldi.* Catch rate data (kg/hr) were standardised using a generalised linear mixed model, generating a series of annual indices of relative abundance. Log transformed catch rates were explained 'best' (smallest AIC) by a model including the factors: Year, Month, Region, Vessel-ID and all 2-way interactions. Interactions with Year were modelled as random effects. The standardised indices displayed increased interannual variability, suggesting that fleet effects masked underlying fluctuations in abundance. Environmental influences were explored by correlating relative abundance with SST, Chlorophyll a, wind, SOI and Nino3-4. The only significant correlation was with westerly wind strength in June of the previous year ($r = 0.86$, $p < 0.005$). A positive trend with June/July northerly wind strength was also evident, but not statistically significant. These results suggest upwelling in the region may exert an important influence on *N. gouldi* in southern Australia, at a time known to correspond to a major spawning event, producing the main cohort fished the following year.

Divergence time estimates for major cephalopod groups: evidence from multiple genes.

Jan Strugnell, Jennifer Jackson, Alexei J. Drummond, Alan Cooper

Molecular Evolution, Dept. of Zoology, South Parks Rd, Oxford, OX1 3PS, UK

This is the first study to use both molecular and fossil data to date the divergence of taxa within the coleoid cephalopods (octopus, squid, cuttlefish). A dataset including sequences from three nuclear and three mitochondrial genes (3415 bp in total) was used to investigate the evolutionary divergences within the group. Divergence time analyses were performed using the Thorne/Kishino method of analysis which allows multiple constraints from the fossil record and permits rates of molecular evolution to vary on different branches of a phylogenetic tree. The data support a Paleozoic origin of the Orders Vampyromorpha, Octopoda and the majority of the extant higher level decapodiform taxa. These estimated divergence times are considerably older than paleontological estimates. The major lineages within the Order Octopoda were estimated to have diverged in the Mesozoic, with a radiation of many taxa around the Cretaceous/Cenozoic boundary. Higher level decapodiform phylogenetic relationships appear to have been obscured due to an ancient diversification of this group.

Age and growth of *Loligo duvauceli* and *L. chinensis* from Andaman Sea of Thailand

Natinee Sukramongkol, Kotaro Tsuchiya, Susumu Segawa

Tokyo University of Marine Science & Technology, Konan, Minato, Tokyo 108-8477 Japan,
email: sukramongkol@yahoo.com

Neritic squids *Loligo duvauceli* and *L. chinensis* are the most valuable commercial cephalopods in the fishery of the Andaman Waters, however, their fishery biology is poorly known. This study aims to describe the life history parameters of these species from Andaman Sea of Thailand. The specimens caught by commercial bottom-trawl in Phang-nga Bay and Southeastern area off Phuket Island were obtained from Phuket fish landings between November and December 2002 and from April to August 2005. The length-weight relationship, size at age, size and age at sexual maturity, for both sexes are given. Age was analysed based on the validation of statolith increments and back calculation was made for the estimation of hatching date. Comparative analysis of growth increments using statolith and gladius dorsal surface increments were examined. Males were dominant in the catch for both species, while mature individuals of *L. duvauceli* were caught in all months. The age-size relationship suggests differences in growth rates related to sex and possibly to season.

Ultrastructural insights in the embryonic development of *Idiosepius biserialis* (Mollusca, Cephalopoda)

Jitima Suwanmala[1]; Christian A. Szaffich[2], Janek von Byern[3]; Jaruwat Nabhitabhata[4]

[1]Kasetsart University, The Graduate School, Department of Marine Science Bangkok, Thailand,
email: junepsu@yahoo.com ;

[2]University of Vienna, Faculty of Life Science, Department of Evolutionary Biology
& Emerging Focus: Molecular Phylogenetics, Vienna, Austria, Europe, E-mail: a9707101@unet.univie.ac.at

[3]University of Vienna, Faculty of Life Science, Cell Imaging and Ultrastructure Research Unit, Vienna, Austria,
Europe, E-mail: vByern@freenet.de ; [4]Kasetsart University, Faculty of Science, Department of Zoology,
Bangkok, Thailand, E-mail: jaruwatnabhitabhata@yahoo.com

Earlier studies by Natsukari (1970) and Yamamoto (1988) provide an overview about the embryonic stages of *Idiosepius paradoxus* and show that embryos hatch after 18 days (20°C). Current investigations on *Idiosepius biserialis* from Phuket Island, Thailand indicate that hatching occurs 6 days after oviposition at 28-30°C. Despite the faster embryonic development, staging of *Idiosepius biserialis* is similar to *Idiosepius paradoxus*. In this study two methods were performed on the embryonic development of *Idiosepius biserialis:* Scanning electron microscope (SEM) for external development (morphogenesis) and fluorescence microscope (FM) for gastrulation and internal structures (organogenesis). SEM analysis shows that at the early stages the embryo is entirely covered with large ciliated cells, particularly on the outer yolk sac, the eye and the mantle edge. Strips of cilia can be found around the eye and along the lateral sides of the mantle. A zone of formation, which spreads out during embryonic development (stage 24), expresses the adhesive organ of *Idiosepius biserialis.* But still when hatching the adhesive organ is not fully expressed. Fluorescence microscope examinations in the early blastoderm-stage show different mitotic activity of the nuclei on both sides of the morula.

Distribution of two enoploteuthid species in the north Pacific transition zone

K. Tsuchiya[1], H. Miyata[1], K. Mori[2], T. Kinoshita[2], S. Segawa[1]

[1]Tokyo University of Marine Science & Technology, Konan, Minato, Tokyo 108-8477 Japan,
email: kotaro@s.kaiyoudai.ac.jp

[2]Hokkaido National Fisheries Research Institute, Fisheries Research Agency, Katurakoi, Kushiro,
Hokkaido 085-0802 Japan

Enoploteuthid squids are one of the divergent groups of cephalopods with a large biomass, especially in warm waters. In the Kuroshio-Oyashio transition zone of the Northwest Pacific, two species of enoploteuthids, *Watasenia scintillans* and *Abraliopsis felis* are dominant among the epipelagic cephalopods, and play a key role as an important food item for large pelagic predators. The distribution of these squid was analysed using specimens collected from the waters 35° - 40° N, 140° -165° E by pelagic trawling in May 2000. *W. scintillans,* which is found in the mesopelagic boundary in Japanese waters shows a distinct change in distribution pattern with growth. Early juveniles show a wide, relatively uniform distribution, as a result of passive transportation from the west wind drift of the coastal waters. Adult squid are concentrated in the frontal zone, and their distribution corresponds with the physical structure of the epipelagic zone. Conversely, *A. felis,* possibly the only true transition species widely distributed to the California Current, was distributed west to 145° E. Differences in distribution pattern among size classes are small in this species. The centre of the *A. felis* distribution range seems to be east of survey area, and the population examined forms a marginal part of its geographical distribution.

Comparison between the hatching date back-calculated on statolith growth-ring analysis and the actual hatching period of the oval squid, *Sepioteuthis lessoniana*

Yukio Ueta

Seikai National Fisheries Research Institute, Fisheries Research, 551-8, Taira-machi, Nagasaki-shi Nagasaki 851-2213, Japan. uetadash@fra.affrc.go.jp

The object of the present study is to back-calculate the hatching date of the oval squid from wild populations in Japan using statolith growth-ring analysis, and to compare estimates to the actual hatching period estimated from the occurrence of egg masses. 160 specimens with dorsal mantle lengths of 16-498mm were collected during 1998 and 2005. Number of statolith rings of these specimens was between 18 and 241. Egg-hatching of oval squid in Japan has previously been estimated to be during June to October with the peak period of June to August, by the relationship between embryonic development of egg masses collected in the field and the water temperature. Hatching dates of juveniles and subadults captured during July and December were estimated to be during May and August, but estimates of adults captured during February and July disagreed with the actual hatching period. In some of these adults, discontinued zones were observed in the statolith growth-rings. These results show that low temperature <15°C during February to April and maturation during April to July affect the formation of statolith growth-rings.

Accumulation of persistent organic pollutants and tributyltin in nine species of Atlantic deep sea cephalopods.

M.A. Unger, G.G. Vadas, E. Harvey, M. Vecchione.

NMFS National Systematics Laboratory, National Museum Of Natural History, Washington DC, United States, vecchiom@si.edu;vecchione3@verizon.net

Nine species of deep sea cephalopods were collected from seven locations in the western Atlantic Ocean in May 2003. The species (*Haliphron atlanticus, Gonatus fabrici, Histioteuthis reversa, Mastigoteuthis magna, Octopoteuthis sicula, Taonius pavo, Teuthowenia megalops,* and *Vampyroteuthis infernalis*) were selected for analysis based on their importance as prey for toothed whales and other pelagic predators. Samples were analyzed for butyltins, polycyclic aromatic hydrocarbons, and halogenated organic pollutants. Most samples contained detectable butyltin concentrations and ranged up to 2 ng/g TBT wet weight. PAH were detected in all samples and included biphenyl, pyrene, flouranthene, chrysene, and benzo flouranthenes. Halogenated organic compounds were detected in the majority of the samples at ng/g concentrations and included PCB, hexachlorobenzene, chlordanes, DDT, DDD, DDE, toxaphene, mirex, BDE and methoxy tetra BDE. Accumulation of persistent organic pollutants in these important pelagic prey species has implications for the trophic level transfer of POP in the Atlantic Ocean.

Life cycle and reproductive biology of *Argonauta nodosa* (Cephalopoda: Argonautidae) in southern Brazil

E. Vidal[1]

University of Rio Grande – FURG, Department of Oceanography, Cx. P. 474, Rio Grande RS 96.201-900, Brazil, email: ericavidal2000@yahoo.combr

Aspects of the life history and reproductive biology of *Argonauta nodosa* in southern Brazil (28°-33°S) were studied from samples collected between 1980 and 1990. A total of 116 paralarvae, juveniles and adults (0.6-19 mm mantle length (ML) were collected with bongo nets and an 8 m^2 rectangular mid-water trawl, while 19 adult females (21-50 mm ML) and 27 shells were collected with fence nets. The wide range of sizes obtained provided specimens for a detailed description of the developmental stages of the life cycle of this pelagic octopus. The largest male collected with the plankton net had a ML of 6.5 mm and a hectocotylus of 6.8 mm in diameter. Forty-three hectocotyli were found attached to the gills of 17 females. The number of hectocotyli varied from 1-11 per female and no relationship was found with female size. These hectocotyli were inverted. The presence of several hectocotyli in the mantle cavity of some females suggests that the males could be fairly abundant in the plankton. The eggs found attached to the shells had a mean diameter of 1.46 mm and were in several different developmental stages, indicating intermittent multiple spawning. The significance of these results for understanding the life cycle and reproductive strategy of *A. nodosa* is discussed.

The influence of the pycnocline and primary production on the distribution of paralarval and juvenile cephalopods off southern Brazil

E. Vidal[1]

University of Rio Grande – FURG, Department of Oceanography, Cx. P. 474, Rio Grande RS 96.201-900, Brazil, email: ericavidal2000@yahoo.combr

This study examines the distribution of paralarval and juvenile cephalopods collected during spring of 1989 by the *R/V Meteor* in the continental shelf (46-125) off Santa Marta Grande Cape in Southern Brazil (28° 09' S-29° 56'S). Forty samples were collected with an 8 m^2 rectangular mid-water trawl. An intrusion of tropical water from the Brazil Current (22°C; 36.5) was recorded between 20-40 m, separating warm and less saline water (22°C; 35.2) from colder and more saline water (15°C; 36.4), resulting in a double pycnocline. However, prevailing NE winds led to the upwelling of subtropical water over the shelf. Three species represented 99% of the 628 cephalopods collected: *Illex argentinus* (n=540; 4-40 mm mantle length (ML), with the highest density recorded at a station with marked pycnocline and Chl-a maxima (6.0 mg m-3). *Argonauta nodosa* (n=46; 2-19 mm ML) were collected only at stations with pycnoclines. *Loligo sanpaulensis* (n=42, 2-21 mm ML) had its highest catches at a station with a double pycnocline. No catches were observed where the water column was homogeneous. The relationship between productivity, pycnocline intensity and abundance of young cephalopods suggests that, during upwelling, this coastal region offers suitable conditions for growth of paralarvae and juveniles of the cited species.

Abiotic influences on squid statoliths embryo growth: statoliths as experimental tools in the squid early life-history

Roger Villanueva[1], Natalie A. Moltschaniwskyj[2], Anna Bozzano[1]

[1]Institut de Ciencies del Mar, CSIC, Passeig Maritim de la Barceloneta 37-49, E-08003 Barcelona, Spain, RV: roger@icm.csic.es; AB: bozz@icm.csic.es

[2]School of Aquaculture, Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, Locked Bag 1370, Launceston, Tasmania 7250, Australia. e-mail: Natalie.Moltschaniwskyj@utas.edu.au

Statolith size and growth was used to determine the influence of abiotic factors on the growth of *Loligo vulgaris* and *Sepioteuthis australis* embryos., Recently spawned egg masses collected from the field were incubated in the laboratory under different levels of light intensity, photoperiod, or short periods of low salinity of (30‰). Double tetracycline staining was used to follow statolith growth. Few differences were found between embryos incubated under winter and summer photoperiods, and the same pattern continued during first week after hatching in *L. vulgaris* paralarvae. However, in *L. vulgaris*, constant light conditions produced significantly slower statolith growth both in embryos and paralarvae. In comparison to controls, slower statolith growth in *S. australis* embryos, due to low salinity only occurred when exposed for 72 h. Comparison with previous studies indicates that temperature seems to be the main abiotic factor influencing statolith growth during early stages, however, interaction between all abiotic factors needs to be determined as well as the unknown influence of other isolated factors, as oxygen concentration within the egg mass.

Structure and composition of the adhesive organ of *Idiosepius* (Cephalopoda, Mollusca)

Janek von Byern, Norbert Cyran, Waltraud Klepal

University of Vienna, Cell Imaging and Ultrastructure Research, 1090 Vienna, Austria

Idiosepius is the smallest member of the cephalopods, attaching to sea grass or algae for camouflage with an adhesive organ. The latter consists of five different cell types, which can be distinguished morphologically and by their secretory products. Columnar cells are pear-shaped, densely filled with 1 µm granules. The cells taper towards the surface and end in a hump. Granular cells are oblong, tube-shaped and contain spherical to polygonal granules (3-5 µm in diameter). Goblet cells are round to sac-shaped, filled with finely granular secretory material, and taper towards their apical ends. Interstitial cells, between the secretory cells, are long and slender and free of secretory material. Basal cells are aligned along the basal membrane without any contact to the surface. They contain vacuoles of uniform density. The first three cell types contain different proportions of neutral sugar units and basic proteins, associated with protein-polysaccharide complexes. The histochemical results suggest that attachment is evoked by a "Stefan-type" adhesion instead of a duo-gland adhesive system as found in *Euprymna scolopes.* The available results do not yet allow any conclusions to be drawn about de-adhesion.

Sucker variations on the hectocotylus of *Idiosepius* species

Janek von Byern, Waltraud Klepal

University of Vienna, Cell Imaging and Ultrastructure Research, 1090 Vienna, Austria

The present study shows that the number of suckers on the ventral arms (hectocotyli) is a questionable attribute for species classification. *Idiosepius pygmaeus* from Thailand (n=64) and *Idiosepius pygmaeus hebereri* from Indonesia (n=40) predominantly bear 2 or 3 suckers on the left and 3 suckers on the right ventral arm; single individuals have 1/1, 1/3 or 4/4 suckers. The species *Idiosepius paradoxus* (n=116) possesses the largest range of sucker combinations, bearing 4 to 9 suckers on the left and 5 to 12 suckers on the right ventral arm. More than 50% have 5/6, 5/7, 6/7, 6/8 or 7/9 suckers on the left/right ventral arm, and one individual exhibited 2/4. *Idiosepius biserialis* from Moçambique (n=52) predominantly bear 3/4, 3/5 and 4/6 suckers, while other individuals exhibit 1/3, 4/8, 5/5 or 5/8 on their hectocotylus. In some cases, *Idiosepius pygmaeus* and *Idiosepius picteti* (each with 1/1 suckers on the hectocotylus) or *Idiosepius pygmaeus* and *Idiosepius paradoxus* have similar suckers combinations. The number of suckers on the ventral arms might not be a useful attribute for classifying females but is applicable to distinguish males on the species level.

Phylogenetic relationships among squid of the family Ommastrephidae inferred from mitochondrial DNA sequences

Toshie Wakabayashi[1], Nobuaki Suzuki[1], Taro Ichii[1], Mitsuo Sakai[1], Seinen Chow[2]

[1]National Research Institute of Far Seas Fisheries, 4-5-7 Orido, Shimizu-ku, Shizuoka-shi, Shizuoka, 424-8633 Japan, email: toshiew@fra.affrc.go.jp

[1]National Research Institute of Fisheries Science, 6-31-1 Nagai, Yokosuka-shi, Kanagawa, 283-0316 Japan

The squid family Ommastrephidae is distributed worldwide and includes many species of commercial importance. To clarify the phylogenetic relationships within the Ommastrephidae, partial nucleotide sequence of two mitochondrial loci (16S rDNA [443 bp] and cytochrome c oxidase subunit I [1277 bp]) of 15 ommastrephid species and one outgroup were determined. The molecular data provided new information on problematic species, e.g., *Ornithoteuthis volatilis,* which had been identified by morphological characters, such as the presence of photophores and the form of hectocotylus. Monophyletic status of three subfamilies (Illicinae, Todarodinae, and Ommastrephinae) was supported. *O. volatilis* was comprised in Todarodinae. Within Todarodinae, the genus *Nototodarus* was paraphyletic under all analyses. *Nototodarus sloanii* was determined to be a sister species of *N. gouldi,* and these two species were more closely related to the Japanese common squid *Todarodes pacificus pacificus* than to *N. hawaiiensis.* The results indicated that the form of the hectocotylus is not a reliable character for determining the genus of Todarodinae members. The phylogenetic relationships within Ommastrephinae were not resolved, owing to the great genetic divergence among species.

Squid fisheries, light bulbs and satellites

C.M. Waluda[1], P.G. Rodhouse[1], P.N. Trathan[1], C. Yamashiro[2], C.D. Elvidge[3], V.R. Hobson[3]

[1]British Antarctic Survey, NERC, High Cross, Madingley Road, Cambridge, England, CB3 OET, UK. http://www.antarctica.ac.uk/. clwa@bas.ac.uk, pgkr@bas.ac.uk, pnt@bas.ac.uk.

[2]Instituto del Mar del Perú, Esquina Gamarra y General Valle Chucuito, Apartado 22, Callao, Perú. http://www.imarpe.gob.pe/. cyamashiro@imarpe.gob.pe.3. NOAA National Geophysical Data Center, 325 Broadway, Boulder, Colorado, 80303, USA http://www.ngdc.noaa.gov/ngdc.html. Chris.Elvidge@noaa.gov

Many of the world's fisheries for ommastrephid squid use powerful incandescent lights to attract their quarry. These fishing lights are detectable throughout the oceans using data obtained by the United States Defence Meteorological Satellite Program – Operational Linescan System (DMSP-OLS). Over the last decade, the development of fisheries Geographic Information Systems (GIS) integrating fishery, environmental and satellite data have provided powerful tools for the analysis of patterns of spatial and temporal variability in relation to physical and biological oceanography. Satellite-derived fishing-light data can be used to provide synoptic imagery of the fleet for time periods from a single day to several years and has allowed the study of fleet activity across management and political boundaries, revealing patterns of migration and inter-annual variability in a number of populations. Here we describe and contrast variability in two major ommastrephid fisheries: the Argentine flying squid *Illex argentinus* in the Southwest Atlantic and the jumbo flying squid *Dosidicus gigas* in the Southeast Pacific using GIS and remote sensing methods. Variability in these fisheries is examined and placed in the context of ecosystem variability and regime shift.

Cephalopoda sampled on a "Meteor" cruise in the eastern Atlantic off NW Africa

Kerstin Warnke

Freie Universität Berlin, Malteserstr. 74-100, Haus D, 12249 Berlin, email: Warnke@zedat.fu-berlin.de

Mesopelagic cephalopods were collected between the coast of Morocco and the Canary Islands using an Isaacs-Kidd midwater trawl (IKMT) in the summer of 2005. The IKMT has a mesh size of 6 to 10 mm, a mouth of 6 m^2 and a length of 10 m. Fishing was performed during daytime between 500 and 1000m and at night between 100 and 300 m to the surface. The sampling time-length depended on the fishing depth and ranged between three and six hours. A total of 15 hauls were performed at the two stations 27°32'N and 13°44'W, 26°35'N and 14°59'W. Twenty-eight cephalopods were collected measuring from 1 to 30 cm in body length. Mainly *Spirula* (13 individuals) of different sizes were caught. Additionally 15 cephalopods from five families of the orders Sepiolida and Teuthoida were captured. Photographs were taken to illustrate the great variety of the collected cephalopods.

Sepia cf. *bandensis* hatched and reared in a public inland aquarium

Kerstin Warnke[1], Rainer Kaiser[2], Marco Hasselmann[2]

[1]Palaeontology, Freie Universität Berlin, Malteserstr. 74-100, Haus D, 12249 Berlin, Germany, email: Warnke@zedat.fu-berlin.de

[2]Zoo-Aquarium, Budapester Str. 32, 10787 Berlin, Germany, email: kaiser@aquarium-berlin.de

Twenty mature eggs (approximately 1 cm in diameter) were obtained from the Philippine Islands. The eggs arrived nearly completely developed (about stage XIX-XX after Naef, 1928). They were kept at temperatures between 26 and 27° C in a closed water system with artificial seawater (S 35%). The water quality was checked regularly, especially the nitrite content. First hatchlings with a dorsal mantle length (ML) of about 0.8 cm were observed after one week. All hatchlings left their egg cases within five days during darkness. In the first few weeks the animals were fed daily with 1 to 2 living mysids enriched with high-value protein. *Sepia* cf. *bandensis* is a nocturnal animal. It is remarkable that juvenile *Sepia* cf. *bandensis*, in contrast to many other *Sepia* species, does not bury itself in the sand. In the aquarium it hides itself under *Caulerpa*. When the light was suddenly turned on we observed that the juvenile animals (as already described for the adults) walked over the ground using their lower arms. Prey capture in daytime was observed only once in the first month; no mortality was found and also no evidence of underfeeding was detected, so prey capture must have taken place during the night.

Diel vertical migration of squid in the Oyashio-Kuroshio transition region of the western North Pacific

Hikaru Watanabe[1], Tsunemi Kubodera[2], Masatoshi Moku[3], Kouichi Kawaguchi[4]

[1]National Research Institute of Far Seas Fisheries, 5-7-1 Orido Shimizu, Shizuoka 424-8633, Japan, email: hikaru1@affrc.go.jp

[2]National Science Museum, Tokyo, 3-23-1 Hyakunin-cho Shinjyuku, Tokyo 169-0073, Japan, email: kubodera@kahaku.go.jp

[3]National Fisheries University, 2-7-1 Nagata-Honmachi, Shimonoseki, Yamaguchi 759-6595, Japan, email:moku@fish-u.ac.jp

[4]Ocean Research Institute, University of Tokyo1-15-1 Minamidai, Nakano, Tokyo 164-8639, Japan

We examined the diel vertical migration of squid (2-49 cm ML) in the Oyashio-Kuroshio transition region of the western North Pacific, using day-night sampling from 20 to 700 m depths with a commercial otter trawl in the summer of 1996. Three patterns of diel vertical migration were recognized for five species. (1) Migrant, in which day and night habitats are clearly separated with peak abundance deeper than 300 m during the day and shallower than 60 m at night: *Gonatopsis borealis* and *Watasenia scintillans*. (2) Semi-migrant, in which half of the population migrates to the upper 100 m at night from its daytime habitat of 500-600 m, while the remainder of the population mainly remains in the daytime habitat: *Onychoteuthis borealijaponica*. (3) Non-migrant, in which the habitat is consistently distributed below 400 m: *Histioteuthis dofleini* and *Belonella borealis*. These migration patterns are probably related to the feeding strategy of squids. Migrants have a high-energy lifestyle, migrating into the productive warm epipelagic zone. Non-migrants have gelatinous bodies and poor swimming ability and a low-energy lifestyle, remaining in the unproductive cool mesopelagic zone. Semi-migrants adopt an intermediate strategy, between the other two.

A statistical method to estimate the optimal number of stomach samples to assess the diet of cephalopods

J.C. Xavier[1], D.M. Alves[3], M. Cristo[1], K. Cresswell[2], T.C. Borges[1]

[1]Centre of Marine Sciences (CCMAR), University of Algarve, Faculty of Marine and Environmental Sciences (FCMA), Campus de Gambelas, 8000-117 Faro, Portugal, email: JCCX@cantab.net

[2]British Antarctic Survey, Natural Environment Research Council, High Cross, Madingley Road, Cambridge, CB3 0ET, UK

[3]University of Aveiro, University Campus of Santiago, 3810-193 Aveiro, Portugal

Knowledge of the feeding ecology of cephalopods is key to understanding their role in marine food webs. The most commonly used method to characterize the diet of cephalopods is through the collection of stomach samples. Although this is a widespread method, attention to the specific number of samples required is often neglected. Here, we provide a simple statistical model to estimate the number of stomach samples needed to characterize the diet of cephalopod species. We used a randomization technique, using Microsoft Visual Basic©, to estimate the average number of stomach samples that will cumulatively include all species present in the diet. The program worked by randomly selecting one of the stomach samples and marking off the species present. If not all of the required species were present, the program randomly selected another sample that had not yet been counted. The species present in this sample were subsequently marked off, and the process was repeated until all the required species were present. The entire process was repeated 100 times to give an average number. To exemplify the usefulness of this method, we analyzed stomach samples of the cuttlefish *Sepia officinalis*, collected from Algarve waters (south Portugal). The consumption and diversity of cephalopods of *S. officinalis* and the advantages of using this statistical method are discussed.

Cephalopods caught by non-cephalopod target fisheries: Does it produce damaging effects on the structure of the cephalopod populations?

J.C. Xavier, J. Sendão, T.C. Borges

Centre of Marine Sciences (CCMAR), University of Algarve, Faculty of Marine and Environmental Sciences (FCMA), Campus de Gambelas, 8000-117 Faro, Portugal, email: JCCX@cantab.net

In marine ecosystems where complex multi-species fisheries exist, it is exceptionally difficult to study the effects of fishing on cephalopod populations, especially those cephalopod species that are caught as by-catch or discarded. As cephalopods are short-lived, semelparous (spawn once and die) and opportunistic organisms, with high inter-annual recruitment variability, it becomes imperative to assess the biology of the cephalopod species taken by the main fisheries (e.g. trawling). In this study, we will evaluate the population structure of the most important cephalopod species, in Algarve waters (south Portugal), based on cephalopods taken as by-catch or discards by fisheries operating in the region. Biodiversity, size (mantle length and mass) and maturity of cephalopods were assessed. Analysis will particularly focus on the cephalopod sizes and maturity stages taken by fisheries and the effects on the cephalopod population structure. For example, most specimens of some cephalopod species caught are mostly at an immature stage, which will have a negative effect on the recruitment of those species. These findings will provide a new insight into how fisheries might affect cephalopod species, and their population structure, differently.

Preliminary trial for measurement of activity rhythm in tropical octopuses with special reference to its relation to the environmental variables

Ryoko Yanagisawa[1], Natsumi Kaneko[1], Yuzuru Ikeda[1]

[1]Department of Chemistry, Biology, and Marine Science, University of the Ryukyus, Okinawa 903-0213 JAPAN, email: marphy116@hotmail.com, k058554@eve.u-ryukyu.ac.jp, ikeda@sci.u-ryukyu.ac.jp

Active and inactive behavioral patterns were measured for two tropical octopuses, *Octopus* (*Abdopus*) *aculeatus* and *O. laqueus,* in captivity. These octopuses were collected from the coastal waters of the Okinawa Island in Ryukyu Archipelago between 2004 and 2005 and were held in the experimental tanks (160L) under controlled light conditions (12L:12D, 0–522lx, 26ºC). Behaviors of these two octopuses were continuously recorded for 24 hours by the infrared CCD camera-video system equipped with the tanks. *O. laqueus* moved around in the tank during 3% of light period and 97% of dark period, which suggested the light related activity rhythm of this species. On the other hand, *O.* (*Abdopus*) *aculeatus* moved in the tank during 33% of light period and 67% of dark period. Sudden inducement of lighting in the dark period however did not cause *O. laqueus* to begin moving. These results will be discussed in comparison with behaviors of *O.* (*Abdopus*) *aculeatus* and *O. laqueus* in their natural habitat in Ryukyu Archipelago, where a specific photoperiod and tidal cycle occur.

Three new species of decapodiform cephalopods (Mollusca; Cephalopoda).

R.E. Young[1], M. Vecchione[2], C.F.E. Roper[3]

[1]Department of Oceanography, University of Hawaii, Honolulu, HI, 96822, email: ryoung@hawaii.edu

[2]Systematics Laboratory, National Marine Fisheries Service, National Museum of Natural History, Washington, D.C. 3Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Two new species of oegopsid squids are described here. The first is an *Asperoteuthis* (Chiroteuthidae), and it is based on 18 specimens. This new species has sucker dentition and a funnel-mantle locking-apparatus that are unique within the genus. The second new species is a *Promachoteuthis* (Promachoteuthidae), based on a unique specimen. The tentacle ornamentation of this new species is unique within the genus. We also describe a new genus and a new species of myopsid squid in the subfamily Heteroteuthinae (Sepiolidae); they are based on four specimens. This new genus and species exhibit unique modifications of the arms in males.

Morphology and morphometry of the squid *Lolliguncula brevis* of Brazilian coast: evidences for their taxonomic separation from North Atlantic *Lolliguncula*

Tânia Zaleski, José Angel Alvarez Perez[1]

[1]Universidade Do Vale Do Itajai, Centro De Ciências Technológicasl Da Terra E Do Mar Caixa Postal 360 Itajai Santa Catarine 8802-202 Brazil email: angel.perez@univali.br

The squid *Lolliguncula brevis* (Blainville, 1823) is widely distributed in the western Atlantic but the validity of the taxa for this entire area has been recently questioned based on contrasting morphological features exhibited by specimens from Brazil and the Gulf of Mexico. A morphological and morphometric analysis conducted in 196 specimens collected in 11 localities of the Brazilian coast, confirmed the dominant occurrence of a single species, *L. brevis*, in the entire latitudinal range (8°S – 28°S). In addition several local "morphotypes" could be distinguished, a pattern possibly related to the limited adults and paralarvae displacement capacity and localized environmental conditions. Morphology of specimens from Brazil justified the taxonomic separation of squids from South and North Atlantic into two distinct species of the Genus *Lolliguncullа.* The left ventral hectocotylized arm of males longer than the other arms was the main distinctive feature of Brazilian specimens. The numerous clutches of small round egg capsules deposited by *L. brevis* in Brazilian waters also differed significantly from the individually-fixed elongated ones deposited by the north Atlantic forms. Considering that the Brazilian forms correspond to the original Blainville description and the type locality is Rio de Janeiro, it is suggested that the northeastern Atlantic *Lolliguncullа* is probably a new species.

Trace element distribution in cephalopod statoliths: NanoSIMS provides new insights into nano-scale structure

K. Zumholz[1], T. Hansteen[1], F. Hillion[2], U. Piatkowski[1]

[1]Leibniz- Institute of Marine Sciences, Düsternbrooker Weg 20, 24105 Kiel, Germany, www.ifm-geomar.de; email: kzumholz@ifm-geomar.de ; thansteen@ifm-geomar.de ; upiatkowski@ifm-geomar.de

[2]CAMECA, Courbevoie, France ; www.cameca.fr ; email: hillion@cameca.fr

In this study we applied the novel method NanoSIMS for the first time to cephalopod statoliths to analyse their chemical microstructure. We performed measurements of trace elements with a spatial resolution of 400 nm. This technique makes it possible to analyse *in situ* elemental distributions between organic or inorganic layers, and also nano-scale chemical variations within the heterogeneous structures. As a case study we analysed statoliths of the boreoatlantic armhook squid *Gonatus fabricii.* We found distinct concentration patterns indicating a periodicity in strontium and sodium distributions. Sr and Na show a negative relation, both elements showing alternating patterns, probably corresponding to daily increments. These increments vary in width between 1 and 4 µm. This study demonstrates the excellent suitability of NanoSIMS for nano scale microchemical analyses of aragonite. Possible future applications include not only cephalopod statoliths, but virtually all biomineralized tissues in aquatic organisms like fish otoliths, gastropod statoliths, bivalve shells, foraminifers and corals.

DELEGATE LIST- Cephalopod International Advisory Council Symposium 2006

Name	Organisation	State/Country	Email
Anderson, Prof Frank	Department of Zoology, Southern Illinois University	UNITED STATES	feander@siu edu
Andre, Ms Jessica	Tasmanian Aquaculture and Fisheries Institute, University of Tasmania	TAS	jandre@utas.edu. au
Arkhipkin, Dr Alexander	Fisheries Department, Falkland Islands Government	FALKLAND ISLAND	Saarkhipkin@fisheries.gov.fk
Barbosa, Ms Alexandra	Marine Biological Laboratory	UNITED STATES	abarbosa@mbl.edu
Barratt, Mr Iain	Queens University Belfast	UNITED KINGDO	Mibarratt01@qub.ac.uk
Beatson, Ms Emma	Auckland University of Technology	NEW ZEALAN	Demmbea16@aut.ac.nz;olive.sykes@aut.ac.nz
Bolstad, Ms Kathrin	Auckland University of Technology	NEW ZEALAND	kbolstad@aut.ac.nz;olive.sykes@aut.ac.nz
Bonnaud, Dr Laure	Museum National D'Histoire Naturelle	FRANCE	bonnaud@mnhn.fr
Boucher-Rodoni, Dr Renata	CNRS	FRANCE	cephalo@mnhn.fr
Bradshaw, Dr Matt	Department of Primary Industries, Water and Environment	TAS	Matt.Bradshaw@dpiwe.tas.gov.au
Bustamante, Dr Paco	Laboratoire de Biologie et Environnement Marins	FRANCE	pbustama@univ-lr.fr
Buxton, Professor Colin	Tasmanian Aquculture and Fisheries Institute	TAS	colin.buxton@utas.edu.au
Ceriola, Dr Luca	University of Bari	ITALY	midamail@tin.it
Chang, Dr Cheng-Hua	Graduate Institute of Ecology and Envrionmental Education, National Hualien Univ	TAIWAN	cch@mail.nhlue.edu.tw
Chen, Dr Chih-Shin	Institute of Fishery Biology, National Taiwan University	TAIWAN	ccshin@ntu.edu.tw
Cherel, Dr Yves	CNRS	FRANCE	cherel@cebc.cnrs.fr
Choi, Mr Wallace	The Swire Institute of Marine Science	HONG KONG	wallace_choi@hkusua.hku.hk
De Vries, Ms Melita	University of Adelaide	SA	melita.devries@adelaide.edu.au
Domaschenz, Mr Philip	Australian Fisheries Management Authority	ACT	phil.domaschenz@afma.gov.au
Doubleday, Miss Zoe	Tasmanian Aquaculture and Fisheries Institute, University of Tasmania	TAS	zoeanned@utas.edu.au
Drobny, Ms Paige	University of Alaska Fairbanks	UNITED STATES	fsspd@uaf.edu
Dunning, Dr Malcolm	Department of Primary Industries and Fisheries, Queensland	QLD	malcolm.dunning@dpi.qld.gov.au
Frusher, Dr Stewart	Tasmanian Aquaculture and Fisheries Institute	TAS	stewart.frusher@utas.edu.au
Furukawa, Ms Hiroko	Hakodate City Hall	JAPAN	h-d-furu@sea.ncv.ne.jp
Gillanders, Dr Bronwyn	University of Adelaide	SA	bronwyn.gillanders@adelaide.edu.au
Gomez-Villota, Mr Felipe	Auckland University of Technology	NEW ZEALAND	felgom02@aut.ac.nz;olive.sykes@aut.ac.nz
González, Dr Angel F.	Instituto de Investigaciones Marinas (CSIC)	SPAIN	afg@iim.csic.es
Gonzalez Peralta, Mr Andres	Universidad Autonoma de Baja California Sur	MEXICO	aperalta98@prodigy.net.mx
Goto, Mr Tsuneo	Japan Sea National Fisheries Research Institute, Fisheries Research Agency	JAPAN	tsuneog@affrc.go.jp
Graham, Mr Ken	Cronulla Fisheries Research Centre	NSW	Ken.Graham@fisheries.nsw.gov.au
Grist, Dr Eric	CSIRO Marine and Atmospheric Research	TAS	eric.grist@csiro.au
Guerra, Prof Angel	Instituto de Investigaciones Marinas (CSIC)	SPAIN	brc1@iim.csic.es
Hall, Dr Karina	Murray-Darling Freshwater Research Centre	VIC	karina.hall@csiro.au
Hanlon, Dr Roger	Marine Biological Laboratory	UNITED STATES	rhanlon@mbl.edu
Hashimoto, Mr Hidehiko	Graduate University of Marine Science and Technology	JAPAN	hassyon@hotmail.com
Hayter, Ms Leanne	Zoo Friends - Taronga Zoo	NSW	leanne@zoofriends.org.au

Name	Organisation	State/Country	Email
Himelburg, Ms Rachael		USA	himelburg@yahoo.com
Ho, Ms Chuan-Wen	National Chung Hsing University	TAIWAN	hocw@ntu.edu.tw
Hochberg, Dr F.G.	Santa Barbara Museum of Natural History	UNITED STATES	fghochberg@sbnature2.org
Hoving, Mr Henk-Jan	University of Groningen	NETHERLANDS	H.J.T.Hoving@rug.nl
Ichii, Dr Taro	National Research Institute of Far Seas Fisheries	JAPAN	ichii@affrc.go.jp
Ito, Mr Kingo	Aomori Prefectural Fisheries Research Center	JAPAN	kingo_ito@ags.pref.aomori.jp
Iwata, Miss Yoko	Graduate School of Fisheries Sciences, Hokkaido University	JAPAN	iwayou@fish.hokudai.ac.jp
Jackson, Dr George	University of Tasmania	TAS	george.jackson@utas.edu.au
Johnson, Mr Colin	University of Tasmania	TAS	cojohnso@utas.edu.au
Jorgensen, Ms Elaina	University of Washington/NOAA	UNITED STATES	EMJ1@u.washington.edu
Jouffre, Dr Didier	IRD (Institut de recherche pour le développement)	SENEGAL	jouffre@ird.fr
Kaifu, Mr Kenzo Natsumi	Graduate School of Marine Science and Technology University of the Ryukyus	JAPAN JAPAN	k.kaifu@mx9.ttcn.ne.jpKaneko, Miss k058554@eve.u-ryukyu.ac.jp
Kasugai, Mr Takashi	Port of Nagoya Public Aquarium	JAPAN	t-kasugai@nagoyaminato.or.jp
Katugin, Dr Oleg	Pacific Research Fisheries Centre (TINRO-Centre)	RUSSIA	okatugin@mail.ru
Kelly, Mr Jesse	Dalhousie University	CANADA	j.kelly@dal.ca
Kinoshita, Mr Yasunori	Hokkaido Industrial Technology Center	JAPAN	kinoshita@techakodate.or.jp
Kubodera, Dr Tsunemi	National Science Museum, Tokyo	JAPAN	kubodera@kahaku.go.jp
Kuipers, Mr Matt	University of Tasmania (Aquaculture)	TAS	kuipersm@utas.edu.au
Lacoue-Labarthe, MrThomas	Laboratoire de Biologie et Environnement Marins, FRE-2727, Université La Rochell	FRANCE	thomas.lacoue-labarthe@univ-lr.fr
Lansdell, Mr Matt	CSIRO Marine and Atmospheric Research	TAS	matt.lansdell@csiro.au
Laptikhovsky, Dr Vladimir	Falkland Islands Fisheries Department	FALKLAND ISLANDS	vlaptikhovsky@fisheries.gov.fk
Lefkaditou, Mrs Eugenia	Hellenic Centre for Marine Research	GREECE	teuthis@ath.hcmr.gr
Leite, Miss Tatiana	Fundação Universidade Federal de Rio Grande	BRAZIL	leite_ts@yahoo.com.br
Leporati, Mr Stephen	Tasmanian Aquaculture and Fisheries Institute, University of Tasmania	TAS	scl0@utas.edu.au
Lindgren, Ms Annie	Ohio State University	UNITED STATES	lindgren.11@osu.edu
Lipinski, Dr Marek	Marine and Coastal Management, DEAT	SOUTH AFRICA	lipinski@deat.gov.za
Lu, Prof Chung-Cheng	Department of Life Sciences, National Chung Hsing University	TAIWAN	cclu@dragon.nchu.edu.tw
Marian, Mr José Eduardo	Instituto de Biociências, Universidade de São Paulo	BRAZIL	jeduardo_marian@yahoo.com.br
Martins, Mr Rodrigo	McM/Bayworld/UCT	SOUTH AFRICA	ocersm@lycos.com
McCann, Mr Denis	Denis McCann Pty Ltd	VIC	monmac@netconnect.com.au
McKinnon, Ms Jean	Department of Marine Science, University of Otago	NEW ZEALAND	jean.mckinnon@stonebow.otago.ac.nz
Miller, Ms Alison	Australian Museum	NSW	alisonm@austmus.gov.au
Miske, Mr Volker	Zoologisches Institut und Museum, Ernst-Moritz-Arndt-Universität	GERMANY	volker.miske@teuthis.de
Miyanaga, Ms Sachi	Graduate School of Fisheries Science	JAPAN	sacchi@fish.hokudai.ac.jp
Moltschaniwskyj, Ms Natalie	University of Tasmania - School of Aquaculture	TAS	Natalie.Moltschaniwskyj@utas.edu.au
Monson, Ms Emilee	University of Alaska Anchorage	UNITED STATES	curleefri@yahoo.com
Montgomery, Dr Steven	NSW Department Primary Industries	NSW	montgos@dpi.nsw.gov.au
Nishiguchi, Dr Michele	New Mexico State University	UNITED STATES	nish@nmsu.edu

Nootmorn, Ms Praulai	Andaman Sea Fisheries Research and DevelopmentCenter	THAILAND	nootmorn@yahoo.com
Norman, Dr Mark	Museum Victoria	VIC	mnorman@museum.vic.gov.au
Nottage, Mr Jonathan D.	Earth & Environmental Science, University of Wollongong	UNITED STATES	nottagej@hotmail.com
O'Dor, Prof Ron	Census of Marine Life	UNITED STATES	rodor@coreocean.org
O'Shea, Dr Steve	Auckland University of Technology	NEW ZEALAND	soshea@aut.ac.nz;olive.sykes@aut.ac.nz
Okutani, Dr Takashi	JAMSTEC	JAPAN	okutani@jamstec.go.jp
Olyott, Mr Leonard	Department of Primary Industries and Fisheries	QLD	leonard.olyott@dpi.qld.gov.au
Orr, Dr Pia	Imperial College	UNITED KINGDO	Mp.orr@imperial.ac.uk
Payne, Dr Adam	Renewable Resources Assessment Group	UNITED KINGDO	Ma.payne@imperial.ac.uk
Payne, Dr John	Post	USA	jcpayne@u.washington.edu
Pecl, Dr Gretta	Marine Research Laboratories	TAS	Gretta.Pecl@utas.edu.au
Pernice, Mr Mathieu	UMR 5178, Muséum National d'Histoire Naturelle	FRANCE	pernice@mnhn.fr
Piatkowski, Dr Uwe	Leibniz Institute of Marine Sciences	GERMANY	upiatkowski@ifm-geomar.de
Pierce, Dr Graham	University of Aberdeen	UNITED KINGDO	Mg.j.pierce@abdn.ac.uk
Redd, Mr Kevin	University of Tasmania	TAS	ksredd@postoffice.utas.edu.au
Reid, Dr Amanda	Unaffiliated	NSW	mandy.reid@optusnet.com.au
Rigby, Dr P. Robin	Kyoto University	JAPAN	rbx@hotmail.com
Roberts, Dr Michael	Marine & Coastal Management	SOUTH AFRICA	squid@metroweb.co.za
Robin, Dr Jean-Paul	Université de CAEN	FRANCE	jean-paul.robin@unicaen.fr
Rodhouse, Prof Paul	British Antarctic Survey	UNITED KINGDOM	p.rodhouse@bas.ac.uk
Roper, Dr Clyde	Smithsonian Institution	UNITED STATES	gsquidinc@earthlink.net
Sakai, Mr Kazuaki	Hokkaido University	JAPANK	az-s@fish.hokudai.ac.jp
Sakai, Dr Mitsuo	Nat. Res. Inst. Far Seas Fisheries	JAPAN	sakaimit@affrc.go.jp
Sakurai, Prof Yasunori	Graduate School of Fisheries Scences, Hokkaido University	JAPAN	sakurai@fish.hokudai.ac.jp
Salcedo Vargas, Mr Mario	Southern Institute of Technology	NEW ZEALAND	salcedo.baird@clear.net.nz
Sanchez, Dr Pilar	Institut de Ciencies Del Mar-CSIC	SPAIN	pilar@icm.csic.es
Santos Vazquez, Dr Maria	Begoña University of Aberdeen	UNITED KINGDOM	m.b.santos@abdn.ac.uk;g.j.pierce@abdn.ac.uk
Sato, Mr Noriyosi	Hokkaido University Usujiri Fisheries Station	JAPAN	norico@fish.hokudai.ac.jp
Sauer, A/Prof Warwick	Rhodes University	SOUTH AFRICA	w.sauer@ru.ac.za
Sawada, Dr Kouichi	Fisheries Research Agency, National Research Institute of Fisheries Engineering	JAPAN	ksawada@fra.affrc.go.jp
Scheel, Prof David	Alaska Pacific University	UNITED STATES	dscheel@alaskapacific.edu
Segawa, Prof Susumu	Tokyo University of Marine Science & Technology	JAPAN	segawa@s.kaiyodai.ac.jp
Semmens, Dr Jayson	Tasmanian Aquaculture and Fisheries Institute, University of Tasmania	TAS	jayson.semmens@utas.edu.au
Shaw, Dr Paul	Royal Holloway University of London	UNITED KINGDOM	p.shaw@rhul.ac.uk
Shea, Dr Elizabeth	Delaware Museum of Natural History	UNITED STATES	eshea@delmnh.org
Shimura, Ms Saya	Graduate School of Fisheries Science	JAPAN	shimura@fish.hokudai.ac.jp
Shulman, Miss Danielle	Hopkins Marine Station of Stanford University	UNITED STATES	joyshul@stanford.edu
Sinclair, Dr Billy	Central Queensland University	QLD	b.sinclair@cqu.edu.au
Sobrino Yraola, Dr Ignacio	Instituto Español de Oceanografía	SPAIN	ignacio.sobrino@cd.ieo.es
Spivak, Mr Simon	Blackwell Publishing	VIC	simon.spivak@asia.blackwellpublishing.com

Name	Organisation	State/Country	Email
Stark, Ms Kate	Tasmanian Aquaculture and Fisheries Institute, University of Tasmania	TAS	kate.stark@utas.edu.au
Staudinger, Ms Michelle	University of Massachusetts Amherst	UNITED STATES	mstaudin@nre.umass.edu
Steer, Dr Mike	SARDI-Aquatic Sciences	SA	steer.michael@saugov.sa.gov.au
Strugnell, Dr Jan	British Antarctic Survey	UNITED KINGDOM	j.strugnell@qub.ac.uk
Sukramongkol, Miss Natinee	Tokyo University of Marine Science and Technology	JAPAN	sukramongkol@yahoo.com
Tracey, Mr Sean	Tasmanian Aquaculture and Fisheries Institute, University of Tasmania	TAS	sean.tracey@utas.edu.au
Triantafillos, Dr Lianos	Falkland Islands Fisheries Department	FALKLAND ISLANDS	ltriantafillos@fisheries.gov.fk
Tsuchiya, A/Prof Koutaro	Tokyo University of Marine Science and Technology	JAPAN	koutaro@s.kaiyoudai.ac.jp
Turner, Ms Liz	Tasmanian Museum	TAS	liz.turner@tmag.tas.gov.au
Tutara, Mr Jason	Auckland University of Technology	NEW ZEALAND	jtutara@aut.ac.nz;olive.sykes@aut.ac.nz
Ueta, Dr Yukio	Seikai National Fisheries Research Institute, Fisheries Research Agency	JAPAN	uetadash@fra.affrc.go.jp
Van Gelderen, Miss Rebecca	Tasmanian Aquaculture and Fisheries Institute, University of Tasmania	TAS	rvangeld@utas.edu.au
Vecchione, Dr Michael	NMFS National Systematics Laboratory	UNITED STATES	vecchiom@si.edu;vecchione3@verizon.net
Villanueva, Dr Roger	Institut de Ciencies del Mar (CSIC)	SPAIN	roger@icm.csic.es
Von Byern, Mr Janek	University of Vienna, Cell Imaging and Ultrastructure	AUSTRIA	vByern@freenet.de
Wadley, Victoria	Census of Antarctic Marine Life	TAS	victoria.wadley@aad.gov.au
Wakabayashi, Dr Toshie	National Research Institute of Far Seas Fisheries	JAPAN	toshiew@fra.affrc.go.jp
Wang, Dr Chia-Hui	Institute of Fisheries Science, National Taiwan University	TAIWAN	chiahuiwang@ntu.edu.tw
Warnke, Dr Kerstin	Paläontologie, Freie Universität Berlin	GERMANY	warnke@zedat.fu-berlin.de
Xavier, Dr Jose	Centre of Marine Sciences (CCMAR)	PORTUGAL	jccx@cantab.net
Yamamoto, Dr Jun	Hokkaido University	JAPAN	yamaj@fish.hokudai.ac.jp
Yanagisawa, Miss Ryoko	University of The Ryukyus	JAPAN	marphy116@hotmail.com
Yau, Dr Cynthia	The University of Hong Kong	HONG KONG	cynthia-yau@hkucc.hku.hk
Young, Prof Richard	University of Hawaii	UNITED STATES	ryoung@hawaii.edu
Zumholz, Mr Karsten	Leibniz-Institute of Marine Sciences	GERMANY	kzumholz@ifm-geomar.de
Zunic, Ms Yvonne	Australian Fisheries Management Authority	ACT	yvonne.zunic@afma.gov.au