Baseline Studies of Biodiversity:

The Fish Resources of Western Indonesia

Edited by

D. Pauly and P. Martosubroto

Directorate General of Fisheries, Indonesia

German Agency for Technical Cooperation

International Center for Living Aquatic Resources Management

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DIRECTORATE GENERAL OF FISHERIES
Jakarta, Indonesia

GERMAN AGENCY FOR TECHNICAL COOPERATION
Eschborn, Germany

INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT
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Contents[a]

[a]Including authored "boxes" in formal chapters.

Regional syntheses

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Preface

This book is long overdue: the trawl and acoustic surveys documented here have been conducted some 20 years ago, and several of the fish communities described in the various chapters of this book have been, in the meantime, fished strongly enough to be barely recognizable.

However, no major surveys have been conducted in Western Indonesia since the period covered here (1975-1981). During that period, a convergence of interest had led to a flurry of bilateral and international fisheries development projects along the Indian Ocean coast of Indonesia, in the Java Sea and adjacent waters, funded by German (GTZ) [a], Australian (AIDAB) [b] and Norwegian (NORAD) [c] aid agencies, and by FAO [d].

Twenty years ago (May 1975) is also when the two editors of this book first met; we had both just acquired our MS degrees, and were eager to apply what we had learnt. We became friends, despite our vastly different cultural backgrounds, perhaps aided therein by a car accident that occurred at Pemanukan along the coast of West Java, and which could easily have killed us both.

Although soon separated, and working in very different institutions, we both felt that the surveys we had jointly worked on, and the surveys done shortly thereafter should have been better documented than through internal reports and theses.

One of us used the opportunity provided by a book review to criticize this state of affairs[e]; the other pushed from within the Directorate General of Fisheries (DGF, Jakarta). The result of our joint effort was an official request sent by DGF to GTZ to support the production of a book in which the surveys would be documented and analyzed, and which would complement the excellent volume published jointly by GTZ, DGF and AIDAB documenting the taxonomy of the demersal fishes of Western Indonesia [f].

GTZ agreed, and ICLARM was invited to submit a proposal, accepted in 1991, for a project that would lead to the publication of a book that would not only complement the previous volume on the *Trawled fishes of Southern Indonesia and Western Australia,* but also be made to resemble it. This explains the choice of the format and fonts used here, which differ from those of other items in ICLARM's Studies and Reviews Series.

The book is thus the result of a long chain of events. However, the delay this implied was, we believe, turned from a liability into an asset. Thus, we present not only the results of old surveys, but a new way of interpreting them, in the biodiversity context that has become a major issue for the outgoing 20th century.

The reconceptualization of old surveys into baseline studies of biodiversity is not followed up here in all its ramification, the papers of D. Pauly, G. Bianchi, J. McManus and R. Froese, S. Luna and E. Capuli providing only pointers. However, the survey results made available through this book (and as computer datafiles) should ensure that there is now, indeed, a sound baseline for fish biodiversity studies in Western Indonesian waters. Thus, we are conscious of having crossed a bridge, and we are confident that this book will help its reader realize, for other areas as well, the importance of "old" trawl surveys as source of biodiversity baseline data.

All that is now left for us to do is to thank all involved directly or indirectly in the creation of this book and especially the authors, not only because without them, there would be no book, but also for their agreeing to our rather specific editorial guidelines, and for delivering their papers in a timely fashion - well, almost!

We would like to thank Ms. Eny A. Buchary, Fisheries Centre, UBC, for checking the Indonesian translations.

Also we would like to thank our former colleagues and ship crew for their collaboration during the surveys in which we participated and our present colleagues at ICLARM and FAO for their encouragement of our work on this book.

Finally, we would like to thank GTZ for its support, notably Dr. M. Bilio, and the DGF, especially Mr. Soewito, former Director of Resources Management, for enabling us to make use of the data collected by *R/V Jurong.*

D. Pauly
Manila/Vancouver

P. Martosubroto
Rome/Jakarta

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[a] Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), GmbH, Eschborn, Germany.
[b] Australian International Development Assistance Bureau, Canberra, Australia (now AUSAID).
[c] Norwegian Agency for International Development, Oslo, Norway.
[d] Food and Agriculture Organization of the United Nations, Rome, Italy.
[e] Pauly, D. 1986. On identifying fish species rather than assessing fish stocks: a review of two bodies on the taxonomy of the neritic fishes of the Western Indian Ocean. Naga, ICLARM Q. 9(3):21.
[f] Gloerfelt-Tarp, T. and P. Kailola. 1984. Trawled fishes of Southern Indonesia and Northwestern Australia. AIDAB/DGF/GTZ. 406 p.

Kata Pendahuluan

Buku ini terbit sangat terlambat: survei-survei trawl dan akustik yang didokumentasikan disini dilaksanakan kurang lebih 20 tahun yang lalu, sementara itu beberapa komunitas ikan yang digambarkan dalam beberapa bab di dalam buku ini, telah mengalami tekanan penangkapan yang sangat tinggi sehingga hampir-hampir mereka tidak terlihat lagi.

Namun demikian, tidak ada lagi upaya survei yang besar yang dilaksanakan di perairan Indonesia bagian barat sejak periode survei diatas (1975-1981). Selama periode tersebut, berbagai interest telah mendorong terbentuknya proyek-proyek perikanan bilateral maupun internasional di sepanjang Samudra Hindia, di laut Jawa dan sekitarnya, dibiayai oleh lembaga bantuan dari Jerman (GTZ), Australia (AIDAB) dan Norwegia (NORAD) serta FAO.

Dua puluh tahun yang lalu (Mei 1975) kedua editor buku ini pertama kali bertemu; kami berdua baru saja mengantongi gelar MS, dan sangat berkeinginan mengaplikasikan ilmu yang baru kami peroleh. Kami menjadi teman akrab, walaupun mempunyai latar belakang budaya yang berbeda, barangkali juga dipererat dengan musibah kecelakaan mobil di Pemanukan di pantai Utara Jawa Barat yang hampir-hampir merenggut nyawa kami berdua.

Walaupun kemudian kami berpisah, dan bekerja di institusi yang sangat berlainan, kami merasa bahwa survei-survei dimana kami bekerja bersama, dan survei-survei yang dilaksanakan kemudian akan lebih baik dipublikasikan daripada hanya merupakan laporan survei dan thesis saja.

Salah satu diantara kami memanfaatkan kesempatan dalam suatu resensi buku dengan menyampaikan kritikan akan masalah seperti ini; sedangkan yang lain berusaha meyakinkan dan menyamakan pandangan di Direktorat Jendral Perikanan (DGF, Jakarta). Sebagai hasilnya suatu permintaan resmi dikirim ke GTZ untuk membantu membiayai pembuatan buku ini dimana hasil-hasil survei akan didokumentasikan dan dianalisis, sehingga merupakan pasangan dari buku taksonomi ikan-ikan demersal Indonesia bagian barat hasil publikasi bersama antara GTZ, DGF dan AIDAB.

GTZ menyetujui usulan diatas dan ICLARM diminta untuk membuat suatu usulan proyek yang mana diterima pada tahun 1991, proyek tersebut bermuara pada penyusunan suatu buku yang tidak hanya merupakan pasangan buku "Trawled fishes of Southern Indonesia and Western Australia", *tetapi juga dirancang agar menyerupainya. Oleh karena itu, bentuk dan format buku ini berbeda dengan bentuk dan format dari buku-buku edisi ICLARM's Studies and Reviews Series.*

Dengan kata lain, penyusunan buku ini telah melalui proses yang panjang. Namun demikian, kami percaya bahwa keterlambatan keluarnya buku ini justru memberikan suatu hikmah. Yaitu, kami tidak hanya menyajikan hasil-hasil survei, tetapi juga suatu metode baru dalam menginterpretasikan hasil-hasil tersebut dari segi keanekaragaman hayati, dimana hal terakhir ini menjadi topik besar dalam era meninggalkan abad ke 20.

Konsepsualisasi kembali terhadap hasil survei untuk menjadi studi dasar dari keanekaragaman hayati tidak dibahas secara keseluruhan, tulisan-tulisan D. Pauly, G. Bianchi, J. McManus serta tulisan R. Froese, S. Luna, dan E. Capuli hanya memberikan beberapa petunjuk pokok saja. Tetapi, hasil survei yang disajikan dalam buku ini (dan dalam bentuk file computer) paling tidak menjamin bahwa sekarang telah tersedia suatu data-dasar untuk studi keanekaragaman hayati bagi perairan Indonesia bagian barat. Dengan sadar kami telah meniti suatu jembatan, dan kami yakin bahwa buku ini dapat membantu para pembaca dalam memahami, tentunya termasuk untuk daerah lain juga, akan pentingnya survei trawl yang sudah lewat sebagai sumber data dasar keanekaragaman hayati.

Tidak lupa kami menyampaikan banyak terima kasih kepada semua pihak yang telah terlibat baik langsung atau tidak langsung, dalam penyusunan buku ini; khususnya kepada para penulis, karena tanpa mereka tidak akan tersusun buku ini. Terima kasih atas keterbukaan mereka mengikuti acuan edisi yang agak spesifik, dan akan kerjasama mereka memenuhi jadwal waktu - boleh dikata hampir tepat waktu.

Kami juga mengucapkan terima kasih kepada Eny A. Buchary, Fisheries Centre, UBC, atas bantuannya memeriksa terjemahan Indonesia dari buku ini.

Kami juga berterimakasih kepada semua teman-teman lama termasuk para awak kapal atas kerjasama yang terjalin dan juga kepada teman-teman di ICLARM dan FAO atas dorongan terhadap penyusunan buku ini.

Akhirnya kami menyampaikan terima kasih kepada GTZ akan bantuannya, khususnya Dr. M. Billio, dan DGF, terutama Bapak Soewito, mantan Direktur Bina Sumber Hayati, yang memungkinkan kami memanfaatkan data yang dikumpulkan kapal penelitian Jurong.

D. Pauly
Manila/Vancouver

P. Martosubroto
Roma/Jakarta

DGF Foreword

As part of the implementation of the first five-year development plan in the fisheries sector, Indonesia received technical assistance from various governments (i.e., the Federal Republic of Germany, The Netherlands, Australia) and international organizations of the United Nations (the United Nations Development Programme and the Food and Agriculture Organization) (UNDP and FAO) in the area of resource surveys conducted in many parts of our archipelagic waters. The result of the surveys has enriched our knowledge of various aspects of marine resources including their habitats, which form a useful resource base that directly or indirectly provides a contribution to the development of fisheries in the country.

The multispecies nature of our marine resources represents the complexity of our tropical marine ecology on which our fisheries are dependent. The wealth of the survey data that has been accumulated so far is a good base from which to generate more information provided that review analysis and scrutiny are undertaken. Dr. Daniel Pauly of the International Center for Living Aquatic Resources Management (ICLARM), who has been working in Indonesia during the GTZ-funded Demersal Fisheries Project in the Java Sea in the mid-1970s, and Dr. Purwito Martosubroto of FAO, Dr. Pauly's counterpart during that time and who later became Director of Resources Management at the Directorate General of Fisheries (DGF), have kindly made an effort to coordinate the present review work with many contributions from the international scientific community. This work is certainly a useful endowment to our knowledge of the resources in Western Indonesia.

This book, which represents an in-depth review of the resources and their environment, is not only useful for scientists but also for policymakers and managers - for them to understand the dynamics of fisheries resources upon which our development policy should be based.

Rear Admiral **F.X. Murdjijo**
Director General of Fisheries
Republic of Indonesia

Kata Pengantar DGF

Sebagai salah satu pelaksanaan rencana pembangunan lima tahun pertama di sektor perikanan, Indonesia memperoleh bantuan teknis dari berbagai negara (antara lain dari Pemerintah Jerman Barat, Belanda dan Australia) dan organisasi international yang bernaung dibawah PBB (seperti UNDP dan FAO) dalam bentuk survei di berbagai wilayah perairan kepulauan kita. Hasil survei ini menambah pengetahuan kita akan sumberdaya perikanan laut termasuk tempat hidupnya yang merupakan informasi yang bermanfaat dan langsung atau tidak langsung memberikan sumbangan terhadap pembangunan perikanan kita.

Sifat multispesies sumberdaya laut kita mencerminkan kompleksnya ekologi perairan tropis dimana perikanan kita sangat tergantung akan sumberdaya ini. Data yang telah terkumpul dari berbagai survei merupakan data dasar yang sangat bermanfaat apabila diadakan analisis yang mendalam. Dr. Daniel Pauly dari ICLARM (the International Center for Living Aquatic Resources Management) pernah bekerja di Indonesia dalam rangka proyek Perikanan Demersal Laut Jawa yang dibiayai oleh Pemerintah Jerman Barat (GTZ) pada pertengahan tahun 1970-an dan Dr. Purwito Martosubroto dari FAO yang merupakan rekan kerja Dr. Pauly pada saat itu dan kemudian pernah menjadi Direktur Bina Sumber Hayati di Direktorat Jendral Perikanan, keduanya dengan baik hati mengkoordinasikan upaya review ini, yang juga memperoleh berbagai sumbangan dari masyarakat ilmiah internasional, dan hasilnya merupakan khasanah pengetahuan yang sangat bermanfaat mengenai sumberdaya laut di perairan Indonesia bagian barat.

Buku ini yang merupakan review yang mendalam tentang sumberdaya dan lingkungan yang tidak hanya berguna bagi para peneliti tetapi juga para pembuat kebijakan dan manajer dalam rangka memahami tentang dinamika sumberdaya perikanan, yang mana yang terakhir ini merupakan informasi dasar dalam perumusan kebijaksanaan pembangunan kita.

F. X. Murdjijo
Direktur Jenderal Perikanan
Republik Indonesia

GTZ Foreword

It is with considerable satisfaction that the undersigned sees the present book published. It follows one of the major lines of collaboration between GTZ and ICLARM, i.e., to make sure that valuable data on fish resources collected at great expenditure are made available to the public in order to allow their maximum use by scientists and resource managers. Regarding the JETINDOFISH data, it was long felt that the publication of the beautiful book by Gloerfelt-Tarp and Kailola *(Trawled fishes of Southern Indonesia and Northwestern Australia)* in 1984 could not fully develop its potential without the publication of the whole biological and ecological information obtained from the trawling surveys.

Publishing such enormous amounts of data as were accumulated during the JETINDOFISH cruises was a task that could be shouldered only by a team that was familiar with the area and its fish fauna and who experienced the circumstances under which the cruises were conducted. It was also essential that such a team be backed by an institution with well-established infrastructure for publication purposes and experienced staff for the routine work. There was, therefore, every reason to wholeheartedly agree when Daniel Pauly, after many other useful proposals of this kind, approached me at GTZ with a request to support this new undertaking.

It took a while until all difficulties of administrative and other kinds were overcome; however, the team did not lose courage and continued their tedious work making and tying up loose ends in order to obtain a consistent picture of the resource situation. In doing so, they went well beyond initial expectations: not only were the data from the JETINDOFISH surveys considered but also a number of other sources of pertinent information were tapped, notably a survey of the *R/V Dr. Fridtjof Nansen*, and several other competent colleagues were asked to join the team. The publication of the present book is thus the fruit of a true international effort worth of the much commitment of an international institution such as ICLARM.

The region to which this publication refers is known, with regard to marine organisms, as the richest on Earth. In the last decade, the importance of biodiversity and its protection and conservation to the benefit of future generations has gained increased public attention. This is not simply based on simple cost-benefit considerations, but also on other values. The ensemble of organisms that surround us and of which a considerable number are essential for our survival, is not an endpoint of evolution, but only a stage of it. The capacity for further adaptation of this ensemble to the ever changing conditions of life on Earth depends on the genetic potential held by the organisms currently in existence. Every loss of species reduces this. However, protection of biodiversity can only be successful when we know what we are going to protect. An inventory of species must, therefore, form the basis of conservation and management of the resources. The attempt at reconceptualizing the elaboration of the survey data into a baseline study of biodiversity is thus a very timely effort.

Congratulations and thanks to the editors and the authors and to ICLARM for a remarkable achievement.

Dr. **Martin Bilio**
GTZ Senior Adviser (ret.) for Living
Aquatic Resources Utilization

Kata Pengantar GTZ

Saya merasa sangat bebahagia sekali dengan terbitnya buku ini yang merupakan kelanjutan kerjasama yang baik antara GTZ dan ICLARM, khususnya dalam rangka upaya memberikan jaminan akan data survei yang diperoleh dengan biaya yang cukup besar agar tersedia bagi khalayak ramai dan dapat dimanfaatkan oleh para peneliti serta pengelola sumberdaya perikanan pada umumnya. Mengenai data proyek JETINDOFISH, telah lama dirasakan bahwa terbitnya buku "Ikan-ikan yang tertangkap dengan trawl di perairan Indonesia bagian selatan dan Australia bagian barat laut" *oleh Gloerfelt-Tarp dan Kailola yang terbit pada tahun 1984 tidak akan banyak memberikan manfaat tanpa terbitnya buku ini yang berisi informasi tentang berbagai segi biologi dan ekologi dari ikan-ikan yang tertangkap dalam survei tersebut.*

Menerbitkan hasil analisis data yang banyak dikumpulkan dalam survei JETINDOFISH merupakan upaya yang tidak mudah, hal mana hanya dapat dilaksanakan oleh suatu tim yang memang mengetahui dan memahami daerah survei, sumberdaya dan lingkungannya. Jelas bahwa tim tersebut juga harus didukung oleh institusi yang lengkap dengan sarana publikasi serta staff yang berpengalaman. Oleh karena itu saya menyetujui usul Daniel Pauly beberapa tahun yang lalu agar GTZ dapat memberikan dukungan biaya dalam publikasi ini.

Upaya pembuatan buku ini memakan waktu cukup lama setelah masalah administrasi dapat diselesaikan, namun anggota tim tidak kehilangan semangat dan terus berusaha dengan gigih, menyempurnakan hal-hal yang masih kurang disana-sini dan akhirnya dapat merampungkannya. Hasilnya, tanpa disadari, lebih dari perkiraan awal, yaitu tidak hanya mencakup tulisan dengan sumber data JETINDOFISH saja melainkan juga dari sumber informasi lain yang terkait, seperti halnya dari survei kapal penelitian Dr. Fridtjof Nansen, dan dengan dukungan rekan-rekan yang kompeten. Publikasi buku ini merupakan hasil pencerminan kerjasama internasional yang sungguh-sungguh dari organisasi internasional seperti ICLARM.

Sebagaimana kita ketahui bahwa daerah survei meliputi Indonesia bagian barat yang merupakan daerah yang terkaya akan sumberdaya lautnya. Dalam dekade terakhir ini arti penting keanekaragaman hayati dan upaya perlindungan serta konservasi, demi generasi yang akan datang, telah banyak memperoleh dukungan masyarakat. Pandangan ini tidak hanya berdasar kepada pertimbangan untung rugi dari segi ekonomi semata tetapi juga bertumpu kepada nilai-nilai lainnya yang terkandung. Organisme di sekeliling kita sebagian besar diperlukan bagi kelangsungan hidup manusia. Kemampuan organisme tersebut untuk beradaptasi terhadap lingkungan yang terus berubah tergantung kepada potensi genetiknya. Dengan punahnya salah satu spesies berarti berkurangnya kekayaan genetika. Perlindungan terhadap keanekaragaman hayati hanya akan berhasil kalau kita memahami benar apa yang mau kita lindungi. Oleh karena itu, inventarisasi spesies merupakan dasar pokok konservasi dan pengelolaan sumberdaya. Upaya mengkonseptualisasikan elaborasi hasil survei ini sebagai dasar studi keanekaragaman hayati adalah merupakan upaya yang tepat sekali.

Selamat dan terimakasih kepada para editor dan para penulis, demikian halnya kepada ICLARM atas hasil yang tiada taranya ini.

Dr. ***Martin Bilio***
Penasehat Senior Pemanfaatan
Sumberdaya Hayati Perairan GTZ

ICLARM Foreword

The International Center for Living Aquatic Resources Management (ICLARM), takes great pleasure in publishing this book on the fish resources of Western Indonesia.

We believe the book will be valuable because of the very geographic location it examines - containing perhaps the most biologically diverse and rich assemblages of marine life known. But it also will have relevance well beyond Indonesian waters. In tropical demersal fisheries, our present knowledge base is quite recent and quite meager compared to that for more temperate regions. For few tropical regions therefore, do we have such a comprehensive scientific analysis including oceanography, climate, ecosystem and the biology of the major fished species. An additional value in this book is the new ground it breaks in analyses of fish diversity.

In addition to the resource surveys documented in its various chapters, this book builds onto important precursors. One of these is the book entitled , "*Trawled fishes of Southern Indonesia and Northwestern Australia*" by Thomas Gloerfelt-Tarp and Patricia Kailola, published in 1984 by the Australian International Development Assistance Bureau (AIDAB - now AUSAID), Canberra, Australia, the Directorate General of Fisheries (DGF), Jakarta, Indonesia, and the Deutsche Gesellschaft für Technische Zusammenarbeit, GmbH (GTZ), Eschborn, Germany. These three organizations with assistance from the Food and Agriculture Organization of the United Nations (FAO), had conducted, from 1978 to 1981, a series of trawl surveys in Western Indonesia, and the book in question had superbly illustrated and documented the multitude of fish species caught in these surveys.

The present volume, deliberately conceived as a complement to its taxonomically-oriented predecessor, now presents detailed community and other analyses of these, and other surveys in the same region. Moreover, its second longest chapter shows how the list of the fish in Gloerfelt-Tarp and Kailola's book was complemented and updated using FishBase 96 (Froese, R. and D. Pauly, Editors. 1996 *FishBase 96: concept, design and data sources*. ICLARM, Manila, Philippines. 179 p.), the global CD-ROM encyclopedia of fishes, and thus kept "alive", despite now being out of print.

Last but not least, this book also has an antecedent the series of documents emanating from a successful collaboration between Indonesian Institutions and ICLARM, notably "*Indonesian marine fisheries*" (Bailey, C., A. Dwiponggo and F. Marahudin, 1987. ICLARM Stud. Rev. 10. 196 p.), and the atlas of the "*Growth, mortality and recruitment of commercially important fishes and penaeid shrimps in Indonesian waters*" (Dwiponggo, A., T. Hariati, S. Banon, M.L. Palomares and D. Pauly, 1996. ICLARM Tech. Rep. 17, 91 p.).

As well as these precursors, another stimulus to the book presented here was the realization by its senior editor of the usefulness of trawl surveys of unexploited grounds as baselines for biodiversity studies, for providing targets for attempt to rehabilitate depleted demersal stocks and for estimating the economic costs of not rehabilitating such stocks. Considerations of this sort are at the heart of several present ICLARM projects, and this book thus presents themes to which we shall frequently return. The work therefore represents new directions in tropical fisheries data analysis, which we propose to pursue through collaborative research in the future.

This volume is "data-rich". That is, not only the results and conclusions of a study are presented, but also the data that led to these results and conclusions, thus encouraging replication and extensions of the analyses that were undertaken, and avoiding the frequent loss of very costly field data. Today's technology for data storage and retrieval are such that we now have no excuse for the frequent and unfortunate losses of original and valuable data as was characteristic of many earlier development projects.

Here, the data in question are available on request in form of 3.5" diskettes, one with the haul-by-haul trawl data analyzed in these pages, the other with the bulk of the fish length-frequency data collected during the surveys covered by this book.

The present volume, and its precursors, resulted not only from collaboration between institutions, but also between individuals. I conclude, therefore, by commending the editors for having expanded such collaboration to include contributions from colleagues from numerous countries not initially involved in the trawl surveys reported upon here.

Dr. **Meryl Williams**
Director General
ICLARM

Kata Pengantar ICLARM

Pusat Lembaga Internasional Manajemen Sumberdaya Hayati Perairan (ICLARM), merasa berbahagia menerbitkan buku ini yang menyajikan informasi sumberdaya perikanan Indonesia bagian barat.

Kami percaya bahwa buku ini berharga karena berisi penelaahan suatu lokasi yang secara geografis mengandung kehidupan laut, yang kemungkinan, secara biologis memiliki sumberdaya yang paling beragam dan paling kaya akan kelompok-kelompok fauna dan flora. Selain daripada itu, buku ini juga mempunyai keterkaitan di luar perairan Indonesia. Dasar pengetahuan kita masih baru dan sangat sedikit dalam hal perikanan demersal daerah tropis, dibanding dengan pengetahuan kita akan perikanan demersal di daerah beriklim sedang. Hanya sejumlah kecil daerah tropis yang mempunyai analisis ilmiah yang komprehensif semacam ini yang meliputi bidang oseanografi, iklim, ekosistem dan biologi dari sebagian besar spesies ikan yang paling banyak tertangkap. Suatu nilai tambah dari buku ini adalah dengan diciptakannya landasan baru dalam analisis keanekaragaman ikan.

Selain menyajikan hasil berbagai survei sumberdaya yang disusun dalam berbagai bab, buku ini melengkapi beberapa penelitian penting yang telah dilakukan sebelumnya. Salah satunya adalah sebagaimana yang diterbitkan dalam buku yang berjudul "Trawled fishes of Southern Indonesia and Northwestern Australia" *oleh Thomas Gloerfelt-Tarp dan Patricia Kailola, yang diterbitkan pada tahun 1984 oleh Badan Bantuan Internasional Australia (AIDAB - yang sekarang bernama AUSAID), Canberra, Australia, Direktorat Jenderal Perikanan (DGF), Jakarta, Indonesia, dan Lembaga Bantuan Teknik Jerman (GTZ), Eschborn, Jerman. Ketiga lembaga ini, dengan bantuan Organisasi Pangan Sedunia PBB (FAO), dari tahun 1978 hingga 1981 telah melaksanakan suatu rangkaian survei perikanan dengan alat trawl di perairan Indonesia bagian barat, dan buku ini telah mendokumentasikan dan membuat ilustrasi bermacam-macam jenis ikan yang tertangkap dalam survei-survei tersebut.*

Buku yang diterbitkan ini, yang secara sengaja disusun sebagai pelengkap buku-buku terdahulu yang bernafaskan taksonomi, menyajikan berbagai analisis komunitas secara terperinci dan analisis lainnya terhadap kegiatan-kegiatan survei ini dan kegiatan survei lain yang dilaksanakan di daerah yang sama. Selanjutnya, bab terpanjang kedua memperlihatkan bagaimana daftar ikan yang ada dalam buku Gloerfelt-Tarp dan Kailola disajikan kembali dan diperbaharui dengan FishBase 96 (Froese, R. and D. Pauly, Editors. 1996. FishBase 96: concept, design and data sources. ICLARM, Manila, Philippines. 179 p.), yang merupakan ensiklopedia ikan dunia dalam bentuk CD-ROM, dan ini berarti membuat buku diatas tetap hidup, walaupun sekarang sudah tidak terbit lagi.

Selanjutnya, buku ini juga merupakan kelanjutan dari beberapa seri buku yang diterbitkan sebelumnya yang merupakan hasil kerjasama ICLARM dengan beberapa lembaga di Indonesia, khususnya "Indonesian marine fisheries" *(Bailey, C., A. Dwiponggo and F. Marahudin, 1987. ICLARM Stud. Rev. 10, 196 p.), dan atlas* "Growth, mortality and recruitment of commercially important fishes and penaeid shrimps in Indonesian waters" *(Dwiponggo, A., T. Hartati, S. Banon, M.L. Palomares and D. Pauly, 1996. ICLARM Tech. Rep. 17, 91 p.).*

Seperti halnya buku-buku pendahulunya, salah satu motivasi terhadap pembuatan buku ini adalah kesadaran dari editor senior akan manfaat berbagai survei trawl di lokasi perairan dimana belum ada kegiatan eksploitasi, sebagai dasar untuk studi keanekaragaman hayati dalam rangka memberikan target sebagai upaya untuk merehabilitasi stok ikan demersal yang sudah menurun maupun untuk membuat estimasi biaya ekonomi bilamana rehabilitasi tersebut tidak dilakukan. Pertimbangan-pertimbangan semacam ini merupakan jiwa dari berbagai proyek ICLARM, dan buku ini menyajikan wahana acuan yang kerap kali dapat kita tengok kembali. Oleh karena itu, upaya ini merupakan arah baru bagi analisis data perikanan tropis dan merupakan hal yang kami usulkan untuk terus dilaksanakan melalui kerjasama penelitian di masa yang akan datang.

Buku ini "kaya akan data". Yang mana ini berarti bahwa buku ini tidak hanya mengetengahkan hasil dan kesimpulan dari beberapa studi, tetapi juga data yang dipakai dalam analisis. Dengan demikian mendorong untuk dilakukannya upaya replikasi dan perluasan analisis, serta selanjutnya menghindari sering hilangnya data lapangan - yang mana data tersebut sangat mahal harganya. Teknologi masa kini untuk penyimpanan data dan penyajiannya kembali sudah sedemikian majunya sehingga tidak ada alasan untuk sering kehilangan data asli yang berharga, hal mana sering terjadi dalam kegiatan proyek pembangunan terdahulu.

Data yang digunakan dalam buku ini tersedia sesuai dengan permintaan dan disajikan dalam dua buah diskette ukuran 3.5"; satu diskette berisi data setiap tarikan trawl sebagaimana dianalisis dalam buku ini, dan diskette kedua berisi data frekuensi-panjang yang dikumpulkan selama survei yang terliput dalam buku ini.

Buku ini, dan buku-buku sebelumnya, tidak hanya merupakan hasil kerjasama antar lembaga tetapi juga antar individu. Oleh karena itu, sebagai penutup, saya menyampaikan penghargaan kepada para editor yang telah mengembangkan kerjasama untuk mengikutsertakan kontribusi para kolega dari berbagai negara, walaupun mereka tidak ikut dalam kegiatan awal survei trawl yang dilaporkan disini.

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Biodiversity and the Retrospective Analysis of Demersal Trawl Surveys: A Programmatic Approach[a]

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PAULY, D. 1996. Biodiversity and the retrospective analysis of demersal trawl surveys: a programmatic approach *[Keanekaragaman hayati dan telaah ke belakang survei trawl ikan-ikan demersal: suatu pendekatan programatik]*, p. 1-6. *In* D. Pauly and P. Martosubroto (eds.) Baseline studies of biodiversity: the fish resources of Western Indonesia. ICLARM Stud. Rev. 23, 312 p.

Abstract

Demersal trawl surveys of tropical shelves were conducted with increasing frequency and sophistication since the 1920s. Designed originally for the purposes of resources and national development, these surveys are now seen to be ideally suited for reinterpretation as biodiversity baseline studies. The conceptual and practical steps required for this are outlined and illustrated with sample surveys conducted from the mid-1970s to the early 1980s in Western Indonesia.

Abstrak

Survei trawl ikan-ikan demersal di paparan daerah tropis semakin sering dilaksanakan dan bahkan dengan peralatan yang semakin canggih sejak tahun 1920-an. Pada awalnya survei tersebut dirancang dalam rangka pengembangan sumberdaya nasional, namun kemudian survei semacam ini dianggap ideal untuk penelaahan ke belakang sebagai studi dasar keanekaragaman hayati. Langkah-langkah praktis dan terencana yang dilaksanakan dalam survei ini dipaparkan dan digambarkan dengan beberapa survei contoh dalam periode 1970-an sampai 1980-an di perairan Indonesia bagian barat.

Introduction

About 90% of the world fisheries catches originate from shelves, i.e., from the shallow waters - down to 200 m surrounding continents and islands. Of this, the overwhelming bulk stems from softbottom, rather than rocky grounds, or reefs, i.e., from trawlable areas (Gulland 1971; Pauly and Christensen 1993).

Demersal trawl surveys certainly represent the most straightforward way of finding how much and what kind of fish occur in a given softbottom area - not least because they use a gear type (demersal trawls) - initially developed for commercial fishing.

Depending on the distributions of their "stations" (or "drags" or "hauls"), three types of surveys may be distinguished:

- opportunistic,
- systematic and
- (stratified) random.

The first of these, mainly of historical interest, consists of a research vessel (e.g., the *Beagle*, or the *Challenger)* fishing occasionally, but without aiming at representative coverage. Systematic and random surveys differ from opportunistic surveys in that both are planned to cover a given *area*, the former through series of hauls placed along parallel lines as for the *R/V Mutiara 4* surveys (see Pauly et al., this vol. and Venema, this vol.), the latter through the statistically more powerful randomization of the position of hauls as for the *R/V Fridtjof Nansen* surveys (see Bianchi, this vol.). The statistical power of random survey can be further increased through stratification, a topic that need not concern us here (but see contributions in Doubleday and Rivard 1981; Pauly 1984).

Important here, rather, is that demersal trawl surveys, though affected by mesh selection and gear avoidance, represent an effective method for obtaining *representative* samples of a (bottom) fish community, covering a wide range of sizes, far more so than for other gears deployed to catch coral reef fishes or pelagic fishes, not to speak of gears for catching terrestrial vertebrates.

This evidently is the reason why trawl surveys are conducted to assess the potential of fisheries and to monitor them, once they have developed. Moreover, and this is the theme of this contribution, trawl surveys, conducted several decades ago to estimate demersal fish biomasses, i.e., to provide the basis for the development of demersal fisheries can be turned, through appropriate retrospective analyses, into baseline studies for coastal biodiversity, and thus to help meet a contemporary challenge.

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Before presenting the elements required for this reconceptualization, I shall recall, however, the key elements of the "development" approach prevailing two to three decades ago, when several major surveys were conducted, both in the tropics, e.g., the Guinean trawling survey in West Africa (Williams 1968), the Gulf of Thailand surveys (Ritragsa 1976), the *R/V Anton Bruun* surveys along the Indian Ocean coast (Hida and Pereyra 1966), and in the cold waters of the North Pacific (Alverson and Pereyra 1972).

Demersal Surveys as Stepping Stones for Development

Demersal surveys, in the 1960s-1970s, consisted of the following major elements:

1. Conduct survey (systematic, later random) in a given area, with funds from development agencies.
2. Have on board the best available field biologists, both from the donor and the surveyed countries, complemented by experts on the taxonomy of the groups covered (and publish fish identification guides if deemed appropriate).
3. Identify and measure the entire catch of each haul, and collect additional data on length composition, maturity stages, stomach contents, etc.
4. Estimate total unexploited biomass (B_o) and estimate "potential yield" (P_y) using the so-called "Gulland equation" now known to generate overestimates (Beddington and Cooke 1983), i.e.,
   $$P_y = 0.5 \cdot M \cdot B_o \quad \textbf{...1)}$$
   where M is the natural mortality (Gulland 1971);
5. Write a few papers on the biology of some of the fish, based on the data in (3) and (4);
6. Leave one of the data sets in a laboratory of the surveyed country, and bring back the other set(s) to a laboratory of the donor country.
7. Disband the staff and forget all about (6).

These steps may not have occurred in all surveys, but all contained several of the elements in (1)-(7). Together, they illustrate all that was good, and that was wrong with these surveys (see Pauly 1986 for a critique).

Thus, two to three decades ago, tropical fisheries development schemes were straightforward: fisheries scientists were to locate the resources, and estimate the amounts that could be extracted from them: hence the emphasis on potential yields. Then a development bank, devoted to industrializing the fisheries, would pick up that number, divide the annual catch of a typical commercial trawler into it, and out came the number of trawlers which construction was to be funded.

Fig. 1 documents this line of thought; it is based on a graph I did as a graduate student to illustrate my version of the then dominant thinking (or lack thereof) about the transition from small-scale to large-scale fishing in tropical developing countries, then perceived as both beneficial and unavoidable.

What this approach brought us is now well known: massive overcapitalization, collapsed stocks, impoverished small-scale fisheries and a need to reconceptualize the entire area of fisheries research and development (Pauly 1979; Pope 1979; Beddington and May 1982; Pauly et al. 1989a; Christy 1993; Pauly 1994, in press; Garcia and Newton, 1995).

The above-described trawl surveys did have positive aspects, however, mainly derived from the nature of trawl hauls as representative samples of demersal fish communities. Thus, the efforts that went into items (2) and (3) led to these surveys providing extremely detailed samples of then largely unfished communities - just what is now needed to serve as baseline for biodiversity studies.

Biodiversity Studies and Their Shifting Baseline

Numerous studies attest to the tremendous impact of direct resource uses, and of habitat destruction on biodiversity - an impact that has accelerated recently, but which has occurred everywhere humans were numerous enough, and had the tools and/or the time to modify those parts of nature surrounding them.

Assessing this impact requires comparisons with some baseline - usually, and almost by definition the oldest available survey. This choice is justified by the fact that, given a continued impact, the more recent the baseline survey one uses, the more it will have shifted toward the present, more impacted situation, and the more human impacts will be underestimated (Pauly 1995).

Conversely, the older the study or survey one uses as baseline, the less the impacts will be underestimated, with all that this implies for attributing value to conservation measures, rehabilitation programs, etc.

Therein lies the worth of old trawl surveys, if their age does not imply a loss of reliability: the theme of the next section.

Retrospective Analyses of Trawl Data: the Issue of Quality

The results of demersal trawl surveys - contrary to the results of other types of biological field studies - are fairly standard in form, always consisting of the following elements:

i. a general description of the survey, involving details on boat, gear, mesh sizes, trawling speed, etc. and applying to all parts (stations) of the survey;
ii. trawling "stations", each defined, as for oceanographic stations, by a place (usually defined by a location on a map, i.e., a longitude and a latitude), a depth (that of the sea bottom), and a time (hour, day, month, year);
iii. a list of the fish and invertebrates caught, often by species, sometimes by higher groups (e.g., genera or families);
iv. the catch taken of each taxon in (iii).

Or in other words: trawl data are typically described by "tables" that are easy-to-computerize (see Alverson and Pereyra 1972 for an early approach to computerization, and Stromme 1992 for a recent one), a theme to which we shall return below.

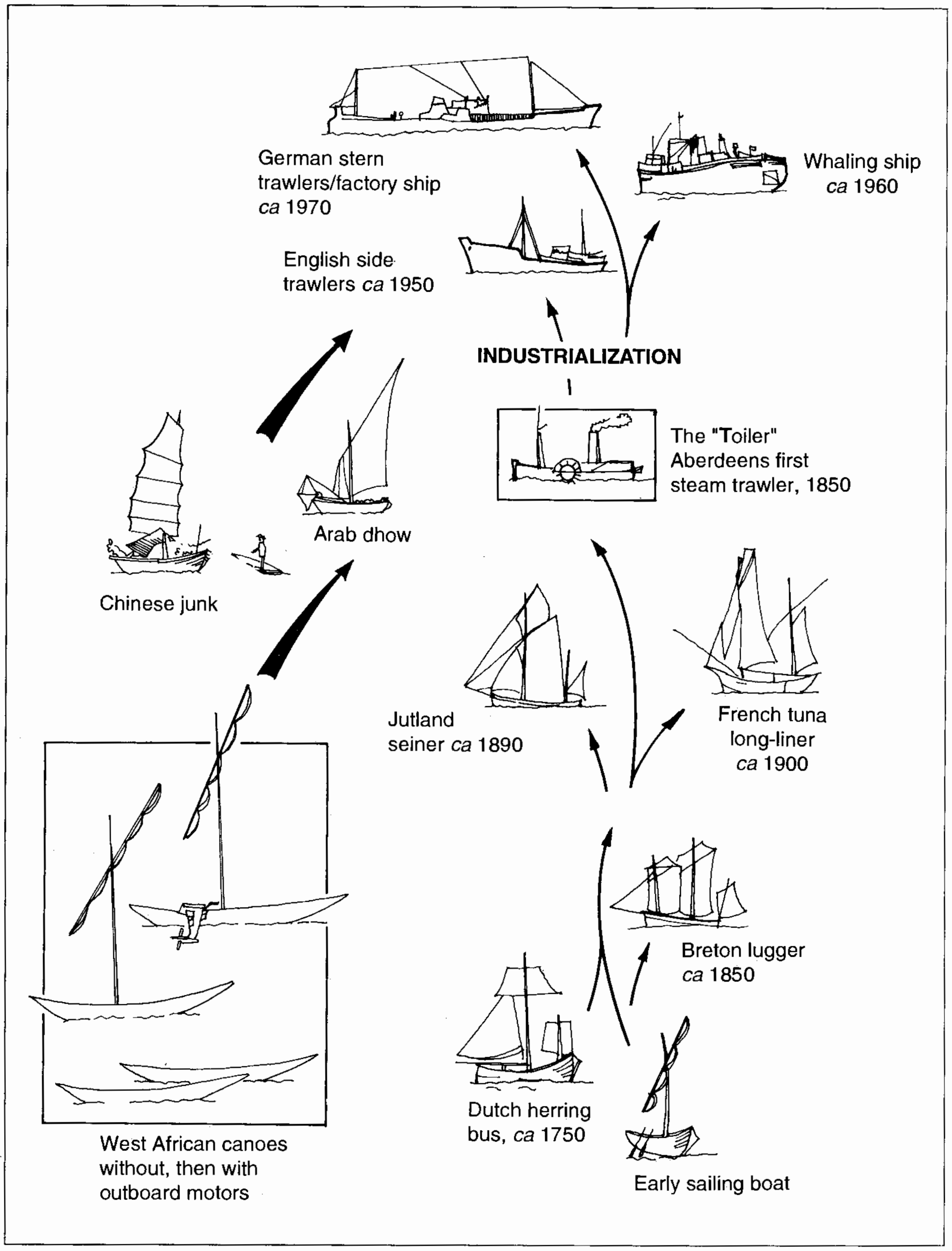

Fig. 1. Historic sequence of European fishing (and other) boat developments, from *ca.* 1750 to *ca.* 1970 (based in part on Muus and Dahlström 1973), assumed to provide a model for the industrialization of fisheries in developing countries. The problem with this "model" is the fact - now obvious - that small-scale fishers cannot be recycled as crew on trawlers nor will simply disappear, once an industrial fleet has been built (adapted from an overhead prepared in 1973 by the author, for presentation at a graduate seminar).
[Gambar 1. Perubahan sejarah perkembangan kapal ikan (dan kapal lainnya) di Eropah dari kira kira tahun 1750 hingga tahun 1970 (sebagian berdasarkan tulisan Muus dan Dahlström 1973) diasumsikan sebagai model proses industrialisasi perikanan di negara berkembang. Kesulitan dalam model ini adalah kenyataan - yang sekarang jelas bahwa para nelayan perikanan skala kecil tidak dengan sendirinya menjadi awak kapal trawl ataupun berhenti profesi dengan dibangunnya armada perikanan industri (diambil dari materi presentasi transparansi penulis yang disampaikan dalam seminar mahasiswa tingkat pasca sarjana tahun 1973 dengan sedikit perubahan).]

To ensure the quality of trawl data one must therefore:

a. have access to the general description in (i) and be able to verify its integrity;
b. be able to duplicate the positions given in (ii) through a reconstruction of the sailing tracks and vice versa, and to check their conformity with modern bathymetric and bottom structure maps;
c. be able to assign current names to the taxa in (iii), which may have outdated names.

Item (c) is the only one that poses real problems; in fact the difficulties involved here would be insuperable were it not for the existence of FishBase, the electronic encyclopedia of fish, which has special routines for the identification of valid (new) names, given (old) synonyms and countries of occurrence (see Froese, this vol.).

Fish generally contribute over 90% of the catch of demersal trawls, and the invertebrates caught along with fish are commonly grouped into larger categories (e.g., "squids"; "sponges", etc., for which translation from "old" to "new" is no problem).

Thus, because of the "tabular nature" of the results of demersal trawl data (see Table 1 for an example), a great amount of trawl survey data can be straightforwardly used, once the table legend (i.e., the general aspects of a survey) and the key column (i.e., the fish names) are verified.

The problem with old demersal surveys, it turns out, is thus not related to quality, but to quantity: it is expensive to have old data computerized (this cannot be reliably done by scanning the original data sheets, as many think). However, modern database techniques can help here, e.g., through preprogrammed entries (e.g., of the species names, which need not be reentered, but can be chosen from a choice list, as in the system developed by Vakily 1992).

Table 1. A typical trawler catch (45-minute haul) from Java Sea (06° 12'S, 108° 26'E, 34-35 m depth) made on 5 September 1976 by *R/V Mutiara 4* in the Java Sea. (Asterisks refer to weight and number raised from a sorted sample of one out of five boxes. Invertebrates not included; see Pauly et al., this vol., for details on the gear used).

[Tabel 1. Hasil tangkapan khas dari trawl (45 menit tarikan) yang dioperasikan di Laut Jawa (06°12'LS, 108°26'BT, pada kedalaman 34-35 m) tanggal 5 September 1976 oleh kapal penelitian Mutiara 4. *Tanda bintang menandakan satuan berat dan angka, yang diperoleh dari proses pemilihan contoh (1 dari 5 boks). Tidak termasuk hewan avertebrata; untuk perincian alat yang dipergunakan lihat Pauly et al., vol. ini.]*

No.	Family	Species	W(kg)	N
1	Ariidae	*Osteogeniosus militaris*	3.4	17
2	Balistidae	*Abalistes stellaris*	0.5	1
3	Carangidae	*Seriolina nigrofasciata*	0.32	1
4	Carangidae	*Scomberoides* sp.	0.15	5
5	Carangidae	*Alepes kalla*	5.0*	90*
6	Carangidae	*Alepes djedaba*	7.5*	290*
7	Carangidae	*Megalaspis cordyla*	8.5*	170*
8	Carangidae	*Selaroides leptolepis*	0.25*	10*
9	Carangidae	*Carangoides* spp.	6.1*	145*
10	Carangidae	*Atropus atropus*	1.75*	30*
11	Chirocentridae	*Chirocentrus dorab*	0.8*	5*
12	Clupeidae	*Anadontostoma chacunda*	0.15*	5*
13	Clupeidae	*Opisthopterus valenciennensis*	1.1*	15*
14	Clupeidae	*Dussumieria acuta*	1.7*	50*
15	Clupeidae	*Ilisha* sp.	5.6*	65*
16	Clupeidae	*Sardinella gibbosa*	0.3*	10*
17	Dasyatidae	not identified	2.65	1
18	Drepanidae	*Drepane longimana*	0.35*	5*
19	Engraulidae	*Stolephorus* spp.	21.0*	4,175*
20	Gerreidae	*Pentaprion longimanus*	15.25*	1,165*
21	Fistulariidae	not identified	0.15*	10*
22	Formionidae	*Formio niger*	0.2	1
23	Lagocephalidae	not identified	4.0	95
24	Leiognathidae	*Leiognathus splendens*	10.0*	720*
25	Leiognathidae	*Leiognathus leuciscus*	4.2*	780*
26	Leiognathidae	*Leiognathus bindus*	1.2*	340*
27	Leiognathidae	*Secutor ruconius*	1.2*	380*
28	Leiognathidae	*Secutor insidiator*	2.8*	560*
29	Lutjanidae	*Lutjanus sanguineus*	4.0	1
30	Lutjanidae	*Lutjanus johni*	5.0*	10*
31	Lutjanidae	*Lutjanus lineolatus*	0.2*	10*
32	Lutjanidae	*Caesio erythrogaster*	0.1*	5*
33	Mullidae	*Upeneus sulphureus*	75.0*	6,075*
34	Nemipteridae	*Nemipterus japonicus*	3.0*	15*
35	Nemipteridae	*Nemipterus bathybius*	0.4*	15*
36	Pentapodidae	*Pentapodus setosus* (?)	0.25*	5*
37	Platycephalidae	not identified	0.25*	5*
38	Plectorhynchidae	*Plectorhynchus pictus*	0.4*	15*
39	Pomadasyidae	*Pomadasys maculatus*	0.25*	5*
40	Pomadasyidae	*Pomadasys* sp.	0.5*	35*
41	Priacanthidae	*Priacanthus macracanthus*	3.1*	80*
42	Scombridae	*Scomberomorus guttatus*	7.2*	65*
43	Scombridae	*Scomberomorus commerson*	2.6	14
44	Scombridae	*Rastrelliger brachysoma*	3.0*	50*
45	Stromateidae	*Pampus chinensis*	0.75	1
46	Stromateidae	*Pampus argenteus*	6.3*	30*
47	Synodontidae	*Saurida tumbil*	0.35	1
48	Synodontidae	*Saurida elongata*	3.75*	45*
49	Synodontidae	*Saurida longimana*	0.9*	105*
50	Sphyraenidae	*Sphyraena obtusata*	0.6*	10*
51	Sciaenidae	not identified	0.25*	5*
52	Terapontidae	*Therapon* sp.	3.75	100
53	Triacanthidae	not identified	1.0*	25*
54	Trichiuridae	*Trichiurus lepturus*	1.0*	55*
55	Trichiuridae	*Lepturacanthus savala*	2.0*	25*
Σ	29 families	43 genera and over 55 spp.	232.02	15,948

Performing Retrospective Analyses: Technical Aspects

Performing analyses of the tabular demersal trawl data presented above may involve:

- reproducing the result of the old survey (see, e.g., contribution by Martosubroto et al., this vol.);
- performing new multivariate (community) analyses (see, e.g., Bianchi, this vol.; McManus, this vol.), related, where possible, to oceanographic and other features of the environments in question (see Sharp, this vol. and Roy, this vol.);
- using the biological and size composition data collected along with the catch data to describe the biology and estimate vital statistics of various species (see, e.g., Pauly et al., this vol.), then to use these and ancillary data (including catches) to construct one or several trophic models of the ecosystem in question (see contributions in Pauly and Christensen 1993 and in Christensen and Pauly 1993.);
- mapping distributions onto phylogenic "trees" to separate taxa that evolved locally from those that immigrated after they had evolved elsewhere (Brook and McLennan 1991);
- performing other analyses, e.g., relating fish weights and numbers through ecological stress indicators (Warwick 1986; McManus and Pauly 1990), or assembling standardized datasets allowing global, simultaneous comparisons of community analyses from a number of surveys, spanning the intertropical belt.

The hardware and software tools exist for analyses that could not have been performed before, and thus for understanding features of tropical fish communities not before apprehended. Indeed, I expect that the biodiversity baseline data emerging by computerizing "old" trawl survey will lead to true discoveries, or at least rigorous test of earlier theories, such as, e.g., A.R. Longhurst's perception of roughly similar communities on both sides of the tropical Atlantic, and of their (distorted) mirror images in the Indo-Pacific (see Longhurst and Pauly 1987).

At the level of individual species, the methods now available for the analysis of length-frequency data (Pauly and Morgan 1987; Gayanilo et al. 1996) enable routine estimation of at least some of the vital statistics of the major species covered by a trawl survey. Moreover, electronic access to the literature on each of these species, through the Aquatic Science and Fisheries Abstracts CD-ROM, and to summaries of biological information on these same species, through the FishBase CD-ROM (Froese and Pauly 1996) will allow quick identification of knowledge gaps, comparisons of results among species, and verification of species lists (Froese et al., this vol.).

Box 1. Uses of boxes.
[Boks 1. Penggunaan boks.]

Most contributions in this volume include "boxes," presenting materials relevant to, but not part of their main narrative.

The use of boxes to present such material has enabled exploring the antecedents (and/or follow-up) of some important issues presented in this book by the authors themselves or by invited contributors. Notably, the development of several fisheries initiated after - and sometimes as a result of - the surveys described here was briefly followed up, e.g., by J. Widodo et al. (see Boxes 3 and 4 in Venema, this vol.) and by A. Ghofar and C. Mathews (see Pauly et al., this vol.). The latter indeed presented a surprisingly close fit between the fluctuation of the important stock of *Sardinella lemuru* in the Bali Straits and the occurrence of El Niño/Southern Oscillation (ENSO) events, a result made possible by their joint analysis of two time series that had hitherto remained disconnected.

We hope that the data assembled for this book and which are available in digital form (see Torres et al., this vol.) will encourage further discoveries of this sort.

Pauly et al. (this vol.) illustrated this new integrated and systematic approach, meant to replace the scattered analyses, covering a few species at best, that have traditionally followed trawl surveys.

Retrospective Analyses: the Institutional Aspects

Although computerization does reduce the workload, few fisheries institutions, or universities can perform all analyses of the data emanating from a set of surveys.

Rather, the scheme used for this book may be recommended: a large number of colleagues, belonging to several institutions were identified and convinced to contribute analyses, each dealing with a subarea, or a period covered by a (set of) survey(s) or even with a "side" aspect of a survey or its consequences (Box 1). This obviously will work only when a project leader, or a small group agree beforehand to help the authors standardize their approach, a *laissez faire* attitude being here completely inappropriate.

Standardization includes - among other things - agreeing on:

- an area (here Western Indonesia: note the consistency between the base maps presented in the various contributions in this book);
- a period (here 1974 to 1981);
- a file format (see Torres et al., this vol.).

(The approach proposed here is evidently the same as that used for previous studies of the anchoveta *Engraulis ringens* and its upwelling ecosystem, covering, on a monthly basis, from 1953 to 1982, the area off Central and Northern Peru, see contributions in Pauly and Tsukayama 1987 and Pauly et al. 1989b).

The large number of authors, from both developing- and developed-country institutions that will have to come together for relevant products to emerge also allows dealing with the thorny issue of scientific credit: all participants can author, or at least co-author a part of the whole story (the issue of credit is further discussed in Pauly 1986, 1993).

Moreover, the standardized databases that emerge from an exercise such as proposed here will become available - in a way that the older, original data were not - to the scientists of the countries in which the surveys were conducted and to the international scientific community. The volume describing the database will thus be a "data-rich book" *sensu* Pauly (1993, 1994), and contribute to solving the data loss problem addressed, e.g., in Janzen 1986 or Mathews 1993, as well as in other disciplines (Levitus et al. 1994).

Readers interested in the application of the approach outlined here to other tropical areas are welcome to contact ICLARM and/or the author.

Acknowledgements

The programmatic approach presented here was inspired by discussions with and the work of Dr. Gabriella Bianchi, Dr. *Fridtjof Nansen* Project, Bergen, Norway, and a seminar by Dr. Meryl Williams, in late 1993 in which she pointed out the need for ICLARM staff to reinterpret their work in the context of biodiversity.

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Oceanography of the Indonesian Archipelago and Adjacent Areas

Oceanography
Geomorphology
Climatology
ISEW, Indonesia
Q1567

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SHARP, G.D. 1996. Oceanography of the Indonesian Archipelago and adjacent areas *[Oseanografi kepu*
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Abstract

Descriptions of the geomorphology and climatology of Southeast Asia are presented as basis for the main oceanographic features of the Indonesian Archipelago. Emphasis is on longer-term global changes and their impact on fisheries resources.

Abstrak

Gambaran geomorphologi dan klimatologi Asia Tenggara disajikan sebagai dasar untuk mengetahui sifat-sifat oseanografi kepulauan Indonesia. Pembahasan ditekankan pada perubahan-perubahan umum jangka panjang dan pengaruhnya terhadap sumberdaya perikanan.

Introduction

Wyrtki (1961) reviewed the geomorphological history and oceanography of the Southeast Asian region, bounded by the Bay of Bengal and Andaman Islands to the northwest, the Strait of Formosa to the northeast, North Australia and the Torres Strait to the southeast and the Indian Ocean to the west-southwest. Appropriately, he gave particular emphasis to the regional consequences of the double monsoon; also, he described the dynamics of sea levels as a result of Pacific Ocean climate changes, and of Pacific to Indian Ocean throughflows. The region clearly comprises some of the more complex geomorphological structures on earth, with high mountains in the north, the deepest known ocean trench (off the east coast of Mindanao, Philippines), numerous volcanic islands along the western boundary of the so-called "rim of fire" (Katili 1989), and a vast assortment of coral islands, shallow shelves and deep channels (Fig. 1). Also, the rivers in the region generate most of the silt deposited on continental selves anywhere on earth (Milliman and Meade 1983; Duinker 1989; Wright 1989).

Topography and Circulation

There are only a few deep channels allowing confluence between the western Pacific and the Indian Ocean. The major ones are the San Bernardino and Surigao Straits within the Philippine Islands chain, where the deep ocean currents ar directed into the eastern portion of the archipelago, to b blocked by the Sunda shelf in the west, and the Arafura she in the east. There are, further, three relatively narrow passage that connect the two oceans: one at Lombok, and two on eithe extreme of Timor, herein referred to as Timor north and Timc south.

Several shallow basins form the Gulf of Thailand, th South China Sea and the Java Sea. To the east the deepe Pacific Ocean reaches from the Celebes Sea southward i Lombok (116°E, 9°S) via the Makassar Strait. Similarly, th Banda Sea opens to the Timor Sea through the Barat Day and Tanimbar Islands, along 5°S, from 126-135°E. The dee Ombai Strait connects the Banda Sea with the Sawu Sea alor Timor north. The surface winds sweep warm surface wate southward throughout the northwest monsoon, from Novemb to February, and the southwest monsoon pushes surfac waters northeastward, back through the shallow sills and strait

Pacific Ocean deep water can only pass through the deep channels such as the Makassar Trough, which is only 2,540 m its deepest, with sills at about 2,300 m depths, while the Tim south channel between Timor and Babar Island (the Timor Trenc reaches 3,310 m. To the north, the narrow Ombai Strait (≈ 5 km) between Timor and the Ator and Barat Daya Islands reach down to only 1,600 m, connecting with the Sawu Basin whic reaches 3,470 m. The deep channels that connect the Flor and Banda Seas with the Indian Ocean have sills between 1,9(and 2,100 m (Postma and Mook 1988; van Aken et al. 1988).

It is presently not well understood what the decadal scale changes in relative forcing might be, but one should assume that they are significant. The Asian continent warming in northern summer and that of Australia in austral summer both act as engines for monsoons. Interannual and decadal climatic patterns and trends reflect the even larger geographic scale of the events affecting the Indonesian archipelago, as consequences of a quasi-biennial oscillation, the El Niño-Southern Oscillation (ENSO), and of longer and global scale climatic and oceanographic processes. Fig. 2 shows some of the global features involved here.

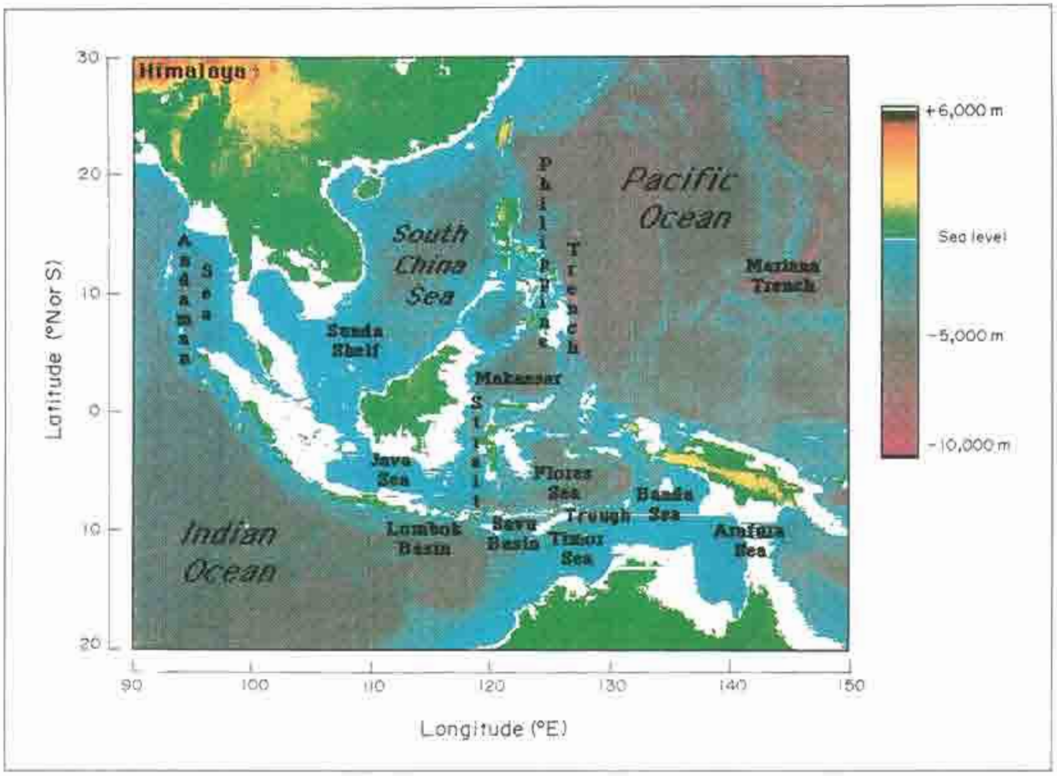

Fig. 1. Relief map of the Southeast Asian region, showing the deepest ocean trenches, some of the world's highest mountains, immense lowlands and shallow archipelagos. Combined with the topographic extremes, climatic forcing from both the Indian and Pacific Oceans, and the continental effects of Asia and Australia, these features generate a dynamic environment whose complexity is reflected by that of the biota.

[Gambar 1. Atlas relief wilayah Asia Tenggara yang menunjukkan palung laut terdalam, sebagian gunung-gunung yang tertinggi di dunia, dataran rendah yang sangat luas dan laut di sekitar kepulauan yang dangkal. Keadaan topografi yang ekstrim, yang dikombinasikan dengan kekuatan energi klimatis dari Samudra Hindia dan Pasifik serta pengaruh benua Asia dan Australia, menciptakan kondisi lingkungan yang dinamis yang mana kompleksitasnya tercermin dari sumber daya hayatinya.]

Regional Climate

The region's double rainy season exhibits two peaks, at the apex of each monsoon period. The double rainfall peak and relatively large terrestrial runoff strengthen the thermal stratification of the upper ocean throughout the region. The shoal warm water that derives from the northern and western areas of the archipelago is therefore relatively lower in salt content than is that deriving from the Pacific Ocean. The north monsoon, which starts in October and peaks in January,

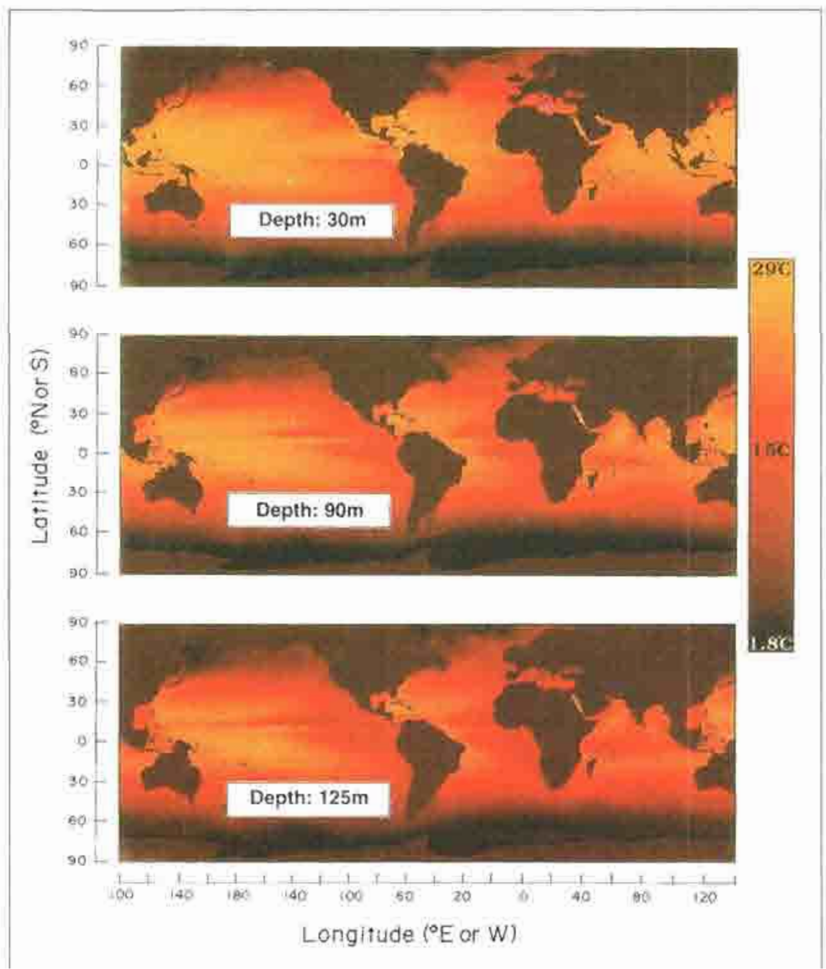

Fig. 2. The extent of the warm tropical (bright) ocean into the global ocean as measured during August (austral winter) when the least tropical heating is expected. Note that at 30 m, the surface ocean is contiguous in the tropical regions, except along West Africa and South America, where the cool Benguela and Humboldt currents dominate; note also that there are no tropical temperatures at 90 m off either of these continents. The deeper tropical influence in the southern Indian Ocean is evidenced by the continuity between the northwest Australian region and Madagascar, even to 125 m. At that depth, only the far western Pacific Ocean, and the region from the Caribbean eastward, and south along Brazil remain strongly tropical. The only complete bridging of any ocean basin at these depths is in the southern Indian Ocean.

[Gambar 2. Luasnya pengaruh laut tropis yang hangat (warna terang) terhadap perairan laut secara keseluruhan selama bulan Agustus (musim dingin di Australia) dimana pengaruh panas tropis sangat kecil. Pada kedalaman 30 m, permukaan laut di daerah tropis seragam, kecuali pada sepanjang pantai Afrika Barat dan Amerika Selatan, dikarenakan adanya pengaruh dominansi arus dingin Benguela dan Humboldt; perlu disimak bahwa tidak ada suhu tropis pada kedalaman 90 m di dekat kedua benua ini. Pengaruh tropis di perairan yang dalam di Samudra Hindia bagian selatan terlihat dari kontinuitas suhu antara wilayah perairan Australia Barat Laut dan Madagaskar, bahkan sampai kedalaman 125 m. Pada kedalaman ini, hanya Samudra Pasifik paling barat, dan wilayah perairan laut dari Karibia ke arah timur serta sepanjang pantai Brazil yang tetap bersifat tropis. Perairan di laut dalam yang saling berhubungan pada kedalaman ini hanyalah di bagian selatan Samudra Hindia.]

pushes the surface currents from north to south until reaching the equator, when they are deflected southeastward.

Rates of throughflow depend on both sea level and surface wind speed and direction. The south monsoon peaks in July-August, when southward transport dominates throughout the water column. This is because surface winds affect primarily the surface currents, and there is always a substantial sea level difference that favors movements of water from the Pacific to the Indian Ocean. These currents from the Pacific Ocean, through the Mindanao Strait into the Celebes Sea can exceed 100 $cm \cdot s^{-1}$ (Postma and Mook 1988). They are then channeled southward through the deep Makassar Strait.

During the south monsoon, the winds force the surface waters westward from the Makassar Strait into the Java Sea (Martosubroto, this vol.). Conversely, the north monsoon forces the surface waters southward, into the Flores Sea, and on through the Timor north and south channels, into the Indian Ocean.

Due to the near continuous monsoon wind forcing, both convergent and divergent, the eastern archipelago is characterized by a continuous 40-50 m mixed layer. However, there is some seasonal upwelling in the Banda and Arafura Sea regions during the south monsoon, leading to shoal oxygen minima, and consequent ecological responses. Because of the very strong north monsoon winds, mixed layer depths can reach 100 m during peak periods. Oxygen is depleted rapidly due to biological activity below the mixed layer; the oxygen minimum ranges from 1.8 to 2.0 $ml \cdot l^{-1}$ at depths greater than 350 m, with local seasonal minima reaching lower values. Wyrtki (1962) also addressed the upwelling (divergence) between Java and Australia, of which a faint signal might be seen in Fig. 3 (April).

Sea surface temperature (SST) varies across the north-south extent of the archipelago, with the greatest variations occurring in the northeast. For example, in the Strait of Formosa, seasonal SST ranges from under 13°C to over 26°C. To the south, within the archipelago and into the northwest Australian region, temperatures range from about 24°C to over 29°C seasonally; this warm, lower salinity surface water is locally responsive to surface forcing. Where topography permits, higher salinity water from the western Pacific Ocean passes over deep sills from east to west in response to the combined dynamics of sea level differences, surface wind forcing and regional barometric pressure, varying on seasonal and longer-time scales.

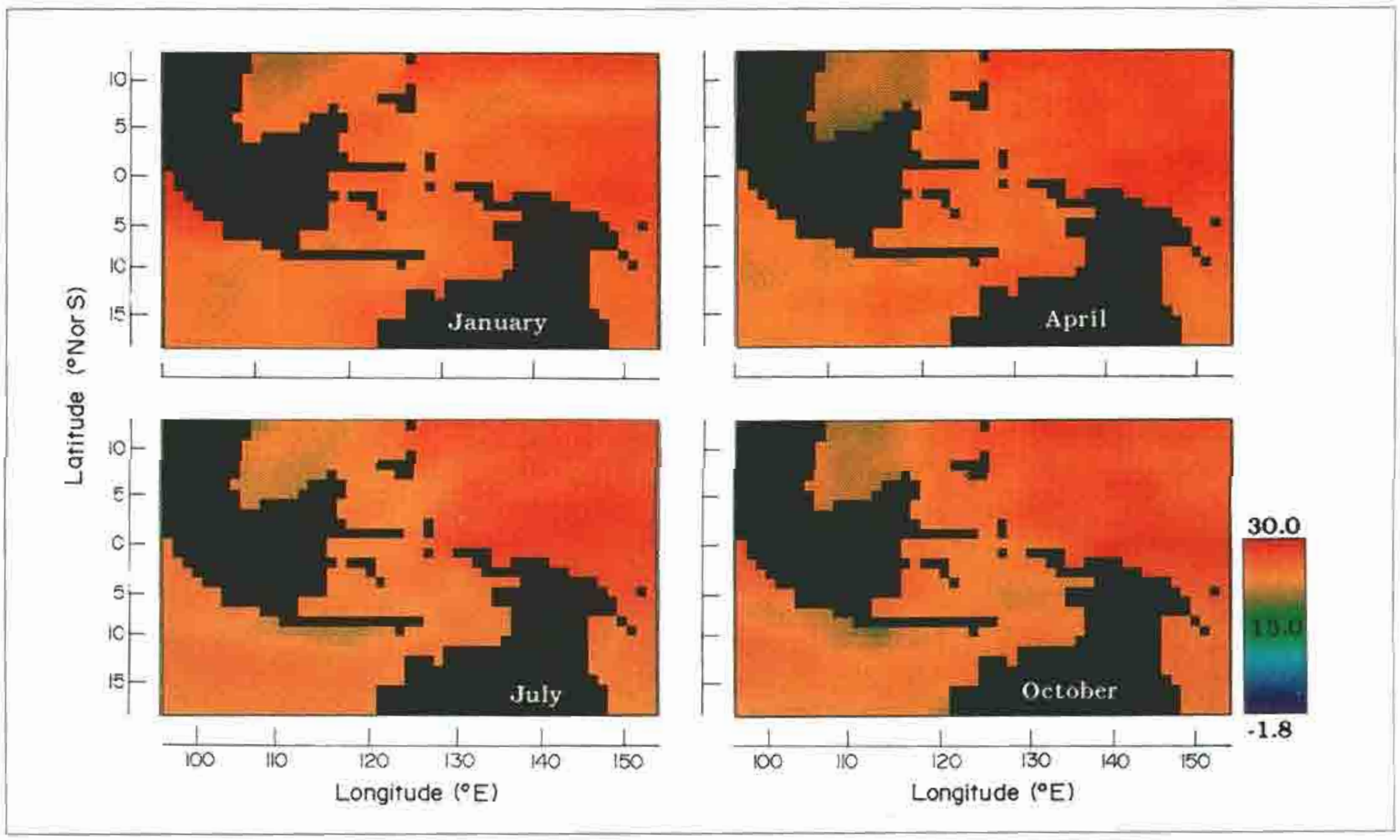

Fig. 3. One degree latitude-longitude mean temperatures at 90 m from the MOODS files (Bauer 1985; Bauer and Robinson 1985). The north monsoon (October to March) forces north-south surface currents, which are reflected in the January warming along the north coast of Australia. In April, the south monsoon begins, and forces surface transport from the Indian Ocean northward into the archipelago. Note that upwelling is indicated by the green coding, correlated with low oxygen levels.

[Gambar 3. Suhu rata-rata pada kedalaman 90 m pada tiap derajat lintang dan bujur sesuai arsip MOODS (Bauer 1985; Bauer dan Robinson 1985). Musim angin utara (Oktober sampai Maret) mendorong arus permukaan utara-selatan sebagaimana tercermin dari pemanasan bulan Januari di sepanjang pantai utara Australia. Pada bulan April, mulailah musim angin selatan yang mendorong arus permukaan dari Samudra Hindia ke utara ke wilayah kepulauan Indonesia. Proses upwelling digambarkan dengan warna hijau yang berkaitan dengan konsentrasi kandungan oksigen yang rendah.]

Recent Interests in Southeast Asia's Environment

The Indonesian Archipelago and the surrounding oceanic and terrestrial systems form a unique set of challenges to ocean modelers and would-be climate forecasters. The principal problem is that the confluence of the western Pacific "warm pool" and the Indian Ocean is severely restricted within the archipelago.

In addition to topography, there are several climatic factors that affect the flow rates between the two ocean basins. The tropical monsoons directly affect the direction of the surface water motion. At ENSO time scales, the changes in regional sea level during the various phases of the ENSO cycle affect the relative strengths and directions of both surface and subsurface flows, a problem first addressed by Wyrtki (1961). He found that during the southwest monsoon (April-September) water exchange occurs at the 125-300 m level while during the northwest monsoon (October through February), the flow is greatest at about 1,000 m.

More recently, Allan and Pariwono (1990), who reviewed the works of Hastenrath and Lamb (1979a, 1979b), Hastenrath and Wu (1982), Nichols (1984a, 1984b), and Hackert and Hastenrath (1986), with emphasis on the relations among SST, radiative effects (clouds) and regional wind forcing suggested that, along with these other important variables, "SST advection and ocean mixing must also be included when considering ocean-atmosphere interactions in eastern Indonesian waters."

Allan and Pariwono (1990) also suggested that ocean mixing is more likely to be important during winter when wind strengths are greater and near-surface flows to the north overlie southward deep throughflows, creating pronounced vertical shear. In the summer, both surface currents and deeper flows are directed southward, and the ocean mixing layer is shallow. During ENSO warm phases, stronger westerlies result in stronger advection. This, coupled with southerly-directed throughflows at depth, results in stronger and more penetrative upper ocean mixing. During cool ("La Niña") events, the opposite is true. Allan and Pariwono (1990) concluded by stating that the sparseness of observations in the Indonesian archipelago precludes more precise estimations of throughflows from the Pacific Ocean to the Indian Ocean, and that due to the above interactions, and the poorly understood consequences of rainfall within the region, a much more complex structure of ocean dynamics will eventually be described.

Wind speed and direction, within the ENSO cycle, have dramatically different consequences on upper ocean temperatures, although the seasonal temperature variations are relatively small within the shallow shelves of the archipelagos (± 1.5°C around a mean of 28.5°C). The deep convection associated with strong early ENSO easterlies enhances the dynamics of both SST and sea level. Increases of the latter induce greater flowthrough, and greater SST leads to enhanced convective transport of upper ocean heat at onset of the pre-summer (October-November) equatorial Pacific westerlies. These trigger Kelvin waves, increased upper ocean heating and deep convection toward the date line, thus promoting conditions conducive to SST rise into the eastern Pacific Ocean. The consequences are a decline in rainfall within the archipelago, and eastward propagation of deep convection and associated storm tracks in the central and eastern Pacific. All of these stages are prognostic of El Niño conditions along the west coast of the Americas.

ENSO-Related Dynamics of the Larger Region

Due to the seasonal dynamics of the Indian Ocean, sea level fluctuations are quite dynamic, reflecting both monsoonal processes and the longer-term ENSO atmospheric pressure fields. During the pre-Niño buildup when persistent westerlies sustain the surface flows across the Pacific Basin, and the southwest monsoon has driven across the Indian Ocean to Indonesia, sea level rises, sometimes reaching knee depth in the streets of downtown Jakarta. Also, upper ocean thermocline structures deepen. Regional drought and raging forest fires are concurrent with sea level rise. In fact, these are precursor signals that provide insights about the eminent release and progression of a Kelvin wave toward the Americas, itself a precursor of El Niño conditions.

Thus, while heat and drought prevail in Southeast Asia and North Australia, the western coasts of the Americas see warmth and deluges. As sea level drops around and in Indonesia, it increases in the eastern Pacific Ocean, reflecting the eastward displacement of vast volumes of ocean midwater. A major consequence of these latter stages of El Niño, i.e., of an ENSO warm event, is the return of a "normal" tropical thermal regime to the equatorial latitudes of South America. It is still not sufficiently recognized that the anti-Niño phase promotes an eccentricity in the global equatorial ocean system in that 14 to 20°C surface waters dominate the coastal and eastern equatorial regions, with profound local and global consequences. This asymmetry destabilizes the entire global thermal balance, and is a major contributor to extraseasonal climate forcing.

The easternmost edge of the warm pool (defined here as some temperature between 27.5 and 28.5°C) has been used as an indicator of ENSO warm events (Fig. 4). Conversely, the depth of the 26 or 28°C isotherm in the western Pacific Ocean can be used to infer the intensity of the heat gains or losses during the ENSO cycle. These are more difficult to portray meaningfully, due to the broad regions involved, and their greater local dynamics. However, once the Kelvin wave is released, sea level falls, westward surface currents decline and the Indo-Pacific throughflow declines. The gravity wave progresses eastward, allowing a shoaling of the western Pacific thermal structure. One little known effect is that the upper ocean thermal structure shoaling promotes catches of the larger tunas normally associated with the deeper, cooler thermal structures. In fact, their appearance in west Pacific purse seine catches is symptomatic of the Kelvin wave, and of a pending decline in catches in the eastern Pacific Ocean, when thermoclines are depressed by that same Kelvin wave. From this, one can

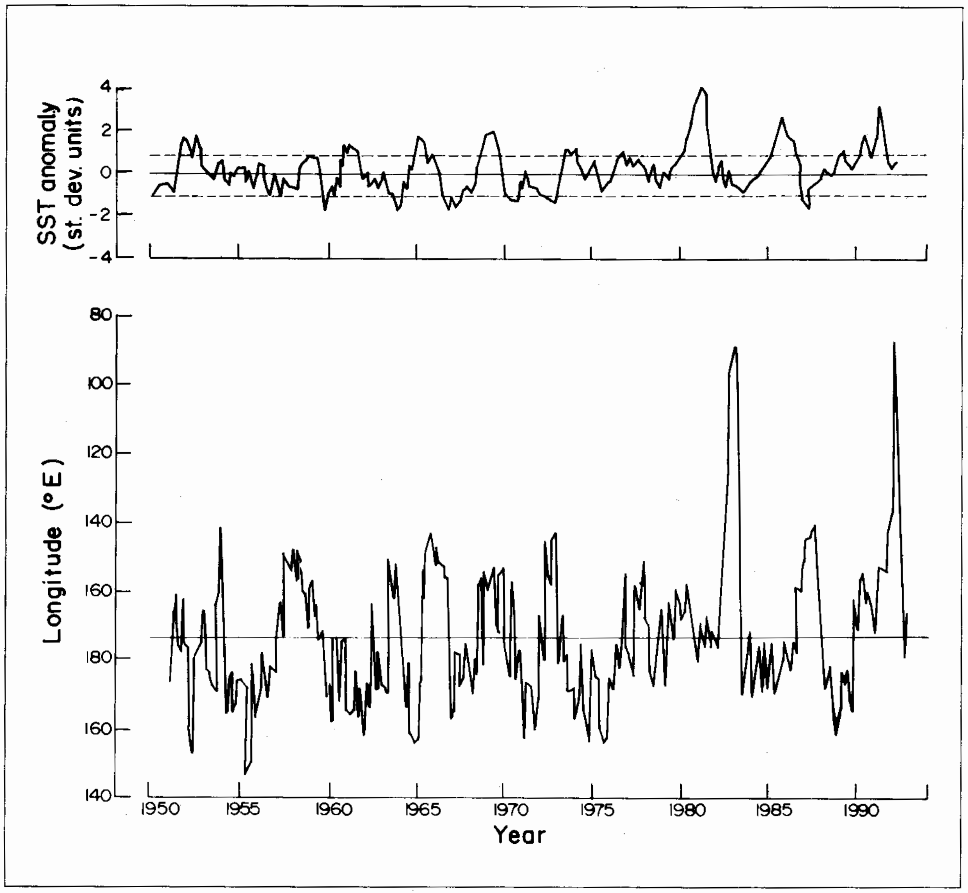

Fig. 4. Time series of ENSO-related processes Upper panel: SST in the El Niño region (offshore c South America). The rise of SST precedes th migration eastward of the 28.5°C isotherm an denotes local heating, not eastward surfac advection of heat. There is no emergent trend, onl two unusual events in the sequence since 195C Lower panel: eastern extent of the 28.5°C surfac isotherm. (Source: Environmental Researcl Laboratories of NOAA, Boulder, Colorado, USA). *[Gambar 4. Data tahunan dari proses yan berhubungan dengan ENSO. Grafik atas: SST c daerah El Niño (perairan lepas pantai Amerik Selatan). Naiknya SST mendorong isotherm 28.5°C bergerak ke timur dan menyebabkan pemanasa lokal, bukan adveksi panas permukaan yang ke timu Tak ada trend tertentu yang muncul, hanya du kejadian yang lain dari biasanya yang secar berurutan terjadi sejak tahun 1950. Grafik bawah besarnya isotherm permukaan 28.5°C di bagia timur. (Sumber: Environmental Researc Laboratories of NOAA, Boulder, Colorado, USA).]*

appreciate that there is more to the ENSO cycle than El Niño warming off the western Americas (see also Ghofar and Mathews, in Pauly et al., this vol.).

The variability among individual ENSO cycles is great, and thus the concept of canonical ENSO cycle has been tossed away, as should also the notion that an east to west movement of warm upper ocean water ensues. Apparently the single most common misunderstanding about the ENSO warm and cool events is a presumption that there is eastward transport of warm surface waters during the initial Kelvin wave that defines the onset of an ENSO warm event. As discussed, each El Niño is triggered by weakening or reversal of tropical westerlies around the date line. The Kelvin wave, a gravity wave, propagates eastward during the latter stages of an ENSO cycle, promoting depression of the thermocline as it passes eastward, as well as local warming of the upper ocean. The Kelvin wave then rapidly passes poleward along the coast, with dramatic consequences that have been well described.

Southeast Asian Archipelago and Downstream Ecological Consequences

A quick examination of Figs. 2 and 3 will show that the temperatures of the surface flow during the southwest monsoon period are sufficient to transport a substantive amount of warm surface waters from the Pacific warm pool southeastward, across the Indian Ocean to Madagascar, and thence to the South African coast. Note also that, due to the shoal isotherm structures of the equatorial Indian Ocean, only in May, June and July can warmer superficial waters be transported into the northeastern Indian Ocean.

There is little direct environment observation data in the literature or in accessible archives for the entire Indo-Pacific region. Much of what is known derives from relatively short-term endeavors, and much of what we would like to know more about now has to be inferred from what is known about the dynamics of the surrounding environment. The compelling data sets that I would like to add to this picture include the broader perspectives of the western and southern Indian Ocean, using monthly time series for depths of the 14°C isotherms as proxies of the decadal scale dynamics of the Warm Pool. This stimulating data set derives from the Master Ocean Observation Set (MOODS). The monthly mean 3x3 degree latitude-longitude data were compiled along the South African coast from Somalia, south through the Moçambique Channel, around into the Benguela upwelling region. Fig. 5 provides information about the recent trends in upper ocean heat content, and changes in patterns from the early 1950s to the late 1970s. The deepening (brightening) of the isotherms around the Cape of Good Hope during the late 1970s until recently was accompanied by the onset of a substantial tropical tuna fishery for yellowfin (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*) and the resurgence of sardines in the coastal environment. The lavender region denotes shoaling of the 14°C isotherm (strong upwelling) within the Benguela upwelling region.

Shackleton (1987) found 20-25 year patterns of coastal pelagic fish scale abundances during examination of laminated sedimentary materials from Walvis Bay, Namibia. Eight cycles

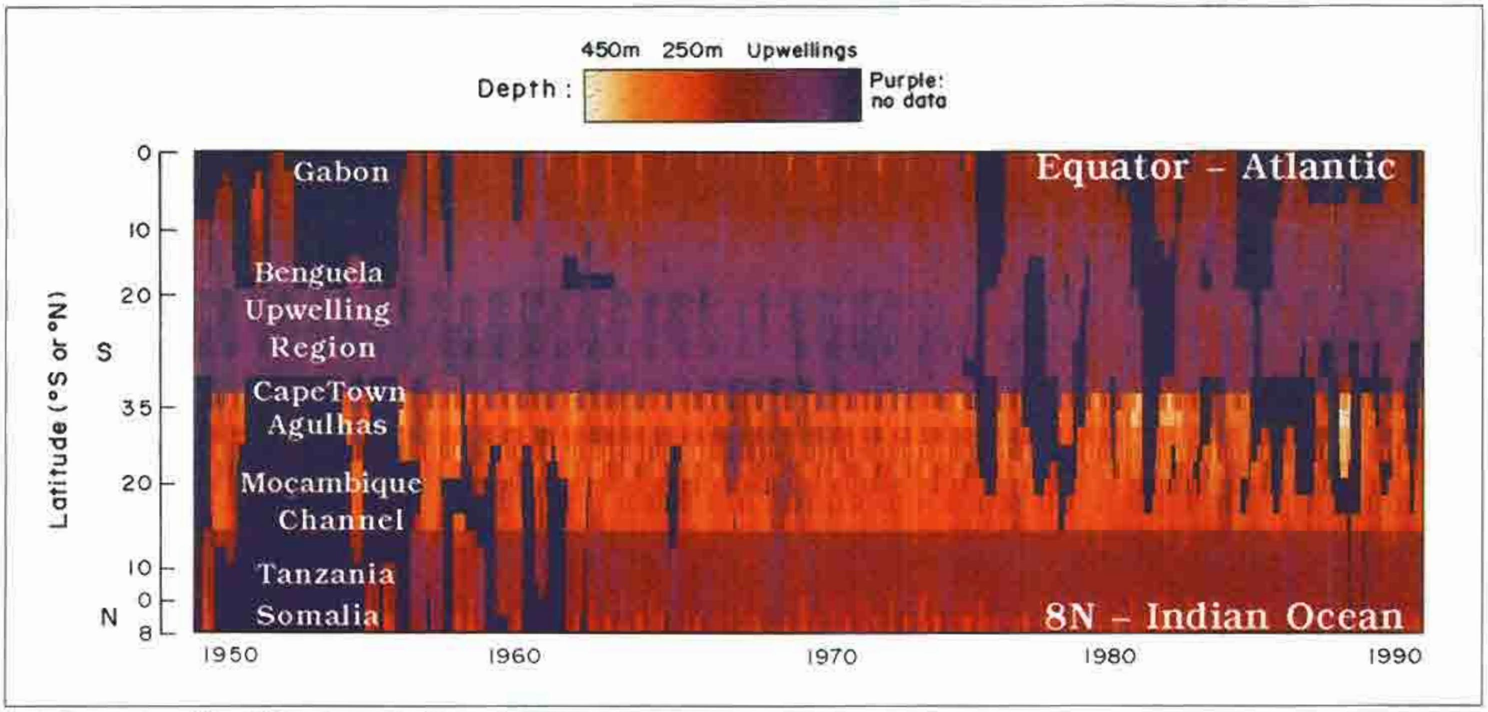

Fig. 5. Time series of the 14°C isotherm, the Congo (equatorial Atlantic) southward through the cool Namibia-Benguela upwelling, around the Cape of Good Hope into the Indian Ocean, i.e., the Moçambique Channel and northward to Somalia's east coast.
[Gambar 5. Isotherm 14°C berdasarkan waktu dari Congo (Atlantik ekuator) ke arah selatan melalui daerah upwelling dingin Namibia-Benguela, melingkari Tanjung Harapan masuk ke Samudra Hindia, melalui selat Mosambik dan ke utara hingga pantai timur Somalia.]

were observed for the 200-year record. There were prolonged periods within these sediments when sardine scales were present (warming periods) and absent (cool, upwelling dominated periods). This suggests that perhaps the natural decadal scale waxing and waning of the Pacific Warm Pool might contribute through strengthening of the southwestward transport of warm upper ocean water during periods of maximal western Pacific Ocean sea level, and throughflow periods associated with strong convergence due to ENSO pressure patterns. Ultimately, the western Indian Ocean consequence of a strong surface throughflow appears to be a suppression of upwelling due to the overlaying of warmer surface waters along the South African coast, with significant ecological results.

Strong equatorial convergences and countercurrents preclude surface water exchanges between the northern and southern Indian Ocean. The deepening of the upper ocean along the southwestern convergence acts as a significant pathway for heat transport from the warm pool to the southwest Indian Ocean, particularly during the northeast monsoon.

The rest of the year, the northern Indian Ocean circulation patterns are dominated by the wind-driven upwelling of cooler oxygen-poor water along the equatorial ocean and along northern coastlines, excluding valuable fish species from their usual deep habitats, and locking out major surface flows from the Pacific Ocean into the northern Indian Ocean (Sharp 1979). The situation is sufficiently limiting for both the Arabian Sea and the Bay of Bengal to become - in ecological terms - nearly enclosed waterbodies. The northern portion of the Arabian Sea, although capable of large surficial exchange, is also affected by emergence of poorly oxygenated waters during substantial periods of the year. However, this is a local phenomenon, and in spite of local oxygen minima, the shoal shelf faunas of the Indo-Pacific consist, if not of exactly the same species, at least of congeners, from Papua New Guinea through Southeast Asia, around the Bay of Bengal and Arabian Sea, and down the east coast of Africa to Madagascar (Longhurst and Pauly 1987; Sharp 1988).

Rich species arrays are found in several areas where complex habitat structures, e.g., rocky shelves and reefs, are collocated with strong, patterned seasonal environments that prevent poorly oxygenated waters from emerging at the surface, e.g., the north coast of Somalia and around the fringes of the Indonesian Archipelago. Although the oceanic species of the equatorial Indo-Pacific are nearly all shared, local physical dynamics, and fresh water dynamics, along with seasonal upwellings determine the species that may occupy each location within the vast coastal and island nursery systems. This provides unique opportunities to compare and contrast physical environments and species interactions. The adjacent regional faunas of the Indian coast along the eastern Arabian Sea and the western Bay of Bengal are very little alike (Sharp 1988), indicating the very distinctive properties of the two physical environments and subsequent ecologies. The remaining living resources are associated with estuaries, river mouths and submerged freshwater seeps, each milieu offering refuge from anoxic upwelled waters.

Much of the coastal upwelling around the northern Indian Ocean derives from Southern Ocean midwater sources. The low-oxygen waters that upwell around the west Irian Jaya coast during wind forcing suggest the occurrence of low oxygen at depth throughout the Indonesian Archipelago, and eastward, all the way to the Pacific Ocean. As described by Bianchi (this vol.), the northwest coast of Sumatra does not exhibit as shoal an oxygen minimum layer as do many of the areas within the Indonesian Archipelago, or around the northern coasts of the Bay of Bengal. This is due to the well mixed upper ocean, and limited primary production across the shelf.

Above the strong thermocline, the temperatures we find are relatively uniformly warm SSTs, ranging between 28 and 29°C around the edges of the warm pool, and between 29 and 30°C within. The shoal warm upper ocean and sharp oxycline suggest that only opportunistic, i.e., short-lived and fecund species will thrive (Dalzell and Pauly 1989; Pauly et al., this vol.). Highly mobile species such as the large tunas and a few related larger predator groups are only abundant at small, younger stages, and for brief periods, as the larger and older stages are tied to cooler oxygenated habitats by their unique thermobiology and respiratory requirements (Sharp and Dizon 1978; Sharp 1979). The few resident scombrid species are all very small (e.g., *Rastrelliger* spp.), or exhibit clear signs of thermal stress, such as early onset of reproduction, and smaller maximum sizes compared to conspecifics from cooler, more oxygenated regions of the adjacent tropical oceans. The food web tends to be broad, but relatively short (Pauly and Christensen 1993, this vol.), due to the intense competition for resources.

Year to year climate-driven ocean variability at local and regional scales is clearly the dominant forcing that affects local fisheries. Venema (this vol.) has documented observations from which it can be inferred that the small-scale structures that oceanographers are prone to removing from their atlas descriptions (e.g., small eddies and current fields) are important. Because of the strong wind forcing, and topographic complexities of the region, eddies and countercurrents should dominate the upper ocean dynamics.

The characteristic situation within the Indonesian Archipelago is further complicated by the dominance of relatively shoal topography, dominated by either coral reef or mangrove ecosystems. Both are affected by the strong vertical stratification set up by monsoonal rainfall and large seasonal inflow of rivers from Asia and the Irian Jaya-Papua New Guinea highlands (Milliman and Meade 1983; Wright 1987).

Conclusion

The dynamic Indonesian Archipelago provides a unique challenge to science. The impact of this domain on global climate is not questioned, it is only the magnitudes of the various competing forces that are yet to be determined.

The ecological dynamics reflect the climate dynamics. What is needed are better observations of the region's ecological and environmental properties before any grand conclusions might be drawn. The region comprises a mosaic of seasonally varying production and system dynamics, all of which interact to generate ecological enigmas. One of these is how to estimate potential yields that are sustainable, in the context provided by myriads of species, embedded in a complex, climate-driven maze of environmental processes and interactions. What little we do know derives primarily from areas in which fishing effort has been very intense for many decades. In other areas less is known, generally due to the absence of human concentrations and activities (Dalzell and Pauly 1989).

As described by Lohmeyer (this vol.), performing pelagic fish surveys using trawling gear within the shoal, warm Indo-Pacific is nearly fruitless. Although numerous schools of surface swimming skipjack (*Katsuwonus pelamis*), longtail tuna (*Thunnus tonggol*), *Scomberomorus* spp., *Rastrelliger* spp. and frigate mackerels (*Auxis* spp.) are often observed, acoustic survey technologies are somewhat insensitive to many of these species either because they lack a gas bladder, or form small schools, and make poor acoustic targets (Venema, this vol.). Even the deepwater crustaceans and other benthic species are likely limited by seasonal oxygen levels, hence cryptic, suggesting that oxygen-rich freshwater seeps or other local phenomena might provide refugia for these species.

In the deeper channels, and open ocean around and about the Indo-Pacific region, wherever oxygen values exceed 1 $ml \cdot l^{-1}$, bigeye tuna (*Thunnus obesus*) and other large predators might be found, but these would certainly never turn up in pelagic trawl surveys. On the other hand, the extensive wide mud-bottomed shoals surrounding regions of seasonal production harbor significant quantities of fishes and other marine resources. However, the high ambient temperatures preclude these species from reaching large size, and compress their life histories, resulting in intensely competitive, high throughput ecosystems, with lower overall abundances and sustainable yields.

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Variability of Sea Surface Features in the Western Indonesian Archipelago: Inferences from the COADS Dataset

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Abstract

Following a brief review of their key properties (based mainly on K. Wyrtki's Naga Report of 1961), sea surface features of the Western Indonesian archipelago are characterized using time series extracted from the Comprehensive Oceanographic and Atmospheric Dataset (COADS), and covering the period from 1950 to 1990.

Abstrak

Diawali dengan tinjauan singkat sifat-sifat pokok dari laut (terutama berdasarkan pengamatan Naga Report 1961 dari K. Wyrtki), sifat-sifat permukaan laut kepulauan Indonesia bagian barat selanjutnya dianalisis berdasarkan data COADS (Comprehensive Oceanographic and Atmospheric Dataset) tahun 1950-1990.

Introduction

This account of the regional oceanography of Western Indonesia, presented here as background to the surveys documented in this volume, is meant to explain observed patterns of productivity (Fig. 1). This account explicitly builds on the comprehensive review of Wyrtki (1961), from which three sections were adapted, other sources of information on the oceanography of the Southeast Asian region being scarce. The mean spatial structure and the seasonal variability of major surface climatic parameters may be found in the Indian Ocean atlas of Hastenrath and Lamb (1979a, 1979b). Sharp (this vol.) also presented an overview of important, large-scale oceanographical and meteorological patterns.

In the introduction to his report on the physical oceanography of the Southeast Asian Waters, Wyrtki (1961) noted that "a considerable number of local effects and features had to be expected". Indeed, the Southeast Asian region has one of the most complex topographical structures on earth: large and small islands subdivide the region into different seas connected with each other by many passages and channels. The variety of the physical settings also generates complex biological systems where local features are important. Thus, "the region comprises a mosaic of seasonally varying production and system dynamics, all of which interact to generate ecological enigma" (Sharp, this vol.). By comparison with other marine ecosystems (see, for example, Parrish et al. 1983 or Pauly and Tsukayama 1987), any kind of generalization remains hazardous.

After a review of some important characteristics of the atmospheric and marine climate of the area, the seasonal and interannual variability of selected surface parameters in six areas, distributed around the Indonesian archipelago, is presented.

The Atmospheric Setting: the Monsoon Regime (Modified from Wyrtki 1961)

The monsoon wind regime is a tropical phenomenon: the result of the interaction between a high atmospheric pressure cell centered over the continent in the winter hemisphere and a low atmospheric pressure cell that develops in the summer hemisphere over the continent, as a prolongation of the equatorial low. Because of the relative stationarity of the pressure distribution, the winds are very steady, especially over the sea. An important characteristic of the area is the biannual signal of atmospheric forcing, related to the movement of the sun and of the equatorial low, which crosses the equator twice each year.

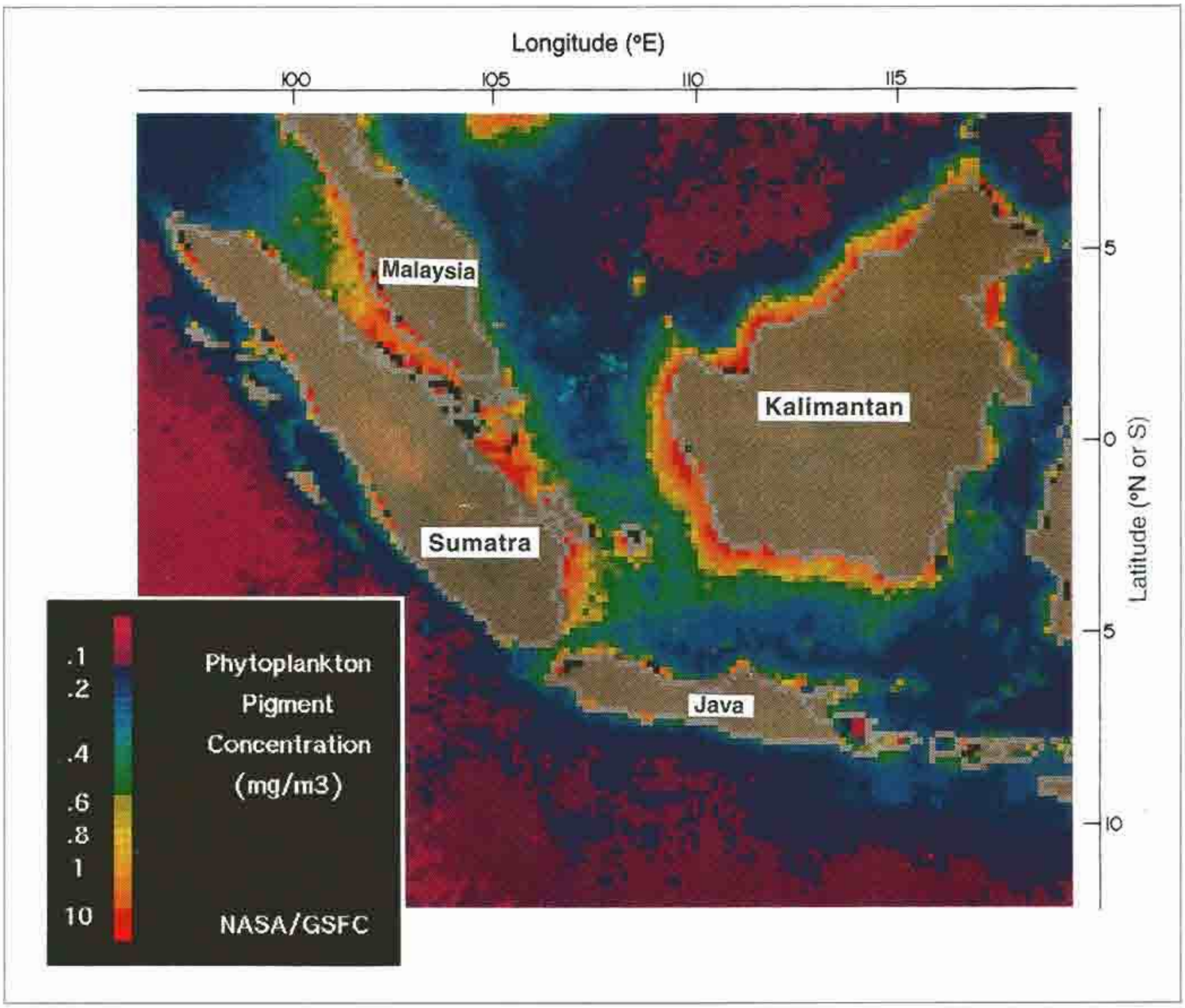

Fig. 1. Composite satellite-derived map of phytoplankton pigment concentrations - indicating primary production levels - for Southeast Asia (courtesy of NASA/GSFC and Dr. F. Chavez, MBARI).
[Gambar 1. Peta komposit konsentrasi phytoplankton berdasarkan beberapa pengamatan melalui satelit yang menunjukkan tingkatan produktivitas primer untuk Asia Tenggara (data NASA/GSFC dan Dr. F. Chavez, MBARI).]

The north monsoon starts in October and is fully developed in January. The monsoon flux passes the equator as a north wind; south of the equator, the wind - due to the Coriolis effect - turns eastward, where it becomes the northwest monsoon. In February, the equatorial low, previously located at 10°S, starts to move northward and comes to lie over Java and the Lesser Sunda Islands. The southeast flux extends to the north. Southwest winds dominate south of the equatorial low, between Java and Australia. North of the equator, the direction of the wind remains unchanged but its strength declines. Little change occurs in April, but a complete reorganization of the atmospheric fluxes is observed in May. The southeast atmospheric flux crosses the equator, then turns eastward. The northeast winds over the China Sea and the Philippines are replaced by the south monsoon, which prevails over the whole of Southeast Asia. The south monsoon reaches its full development between July and August: the Asian low and the Australian high are fully developed and the north-south pressure gradient and atmospheric circulation are maximum. In September at the end of the boreal summer season, the Asian low starts to weaken and in October the equatorial low starts to move southwards. In the north, northeast winds start to dominate. In November, the equatorial low crosses the equator and the northeast monsoon intensifies. The southward reach of the northeast monsoon follows the migration of the equatorial low which attains its southernmost position in January.

This seasonal variability of the winds cause corresponding changes in surface currents. Following the direction of the monsoon flux, which changes twice a year, the currents also reverse themselves twice a year. This is perhaps the key ecological feature in the area (see e.g., Martosubroto, this vol. and Venema, this vol.).

Some Characteristics of the Surface Circulation in the Southeast Asian Waters (Adapted from Wyrtki 1961)

Some topographical features of Southeast Asia favor the development of a strong surface circulation: the area formed by the South China Sea, the straits between Sumatra and Borneo, the Java Sea, the Flores Sea and the Banda Sea which has its main axis aligned with the wind flux during both monsoons; this, along with the relative constancy of the winds favors the development of surface circulation patterns strongly connected to the wind regime. In other parts of the region, however, it is difficult to extract any large-scale and coherent circulation pattern; local effect and intermittency appear to be dominant. Water exchange with the Pacific Ocean occurs through the Molucca Strait, the Philippines, and the Sulu Sea (Sharp, this vol.). The Makassar Strait has usually a current directed to the south, from the Pacific to the Indian Ocean. However, the water exchange through the Malacca and the Sunda Straits is small, even when the currents are strong. In the Java Sea, the surface water flow is directed to the west from May to September and to the east from November to March (Martosubroto, this vol.). In April and October, when the direction of the flow changes, eddies are generated along with a shear between the eastward current off the coast of Java and the westward current off the coast of Borneo. Through the Malacca Strait and the Sunda Strait, the surface currents are generally directed towards the Indian Ocean and are strongly related to the sea level gradient through the straits. The flow through the Sunda Strait reaches its maximum in August, during the southeast monsoon and there is a second maximum in December/January. In the Malacca Strait, the period of strongest flow is from January to April, during the northeast monsoon.

Properties of the Surface Waters (Modified from Wyrtki 1961)

High sea surface temperature (SST >25°C) and small seasonal amplitude (<3°C) are the dominant characteristics of Southeast Asian waters; moreover, their spatial distribution is quite uniform, with small gradient over the entire region.

The high rainfall, which largely exceeds evaporation, causes an average salinity of less than 34‰. This rainfall, the river runoff it causes and the archipelagic nature of the area are responsible for an extremely variable spatial distribution of the surface salinity. The alternance of the monsoons leads to rainy and dry seasons, and thus to large environmental variations. Rivers runoff, notably into the Java Sea, rather than rainfall is the cause of the low coastal salinities, even far offshore. The largest extent of the low salinity waters occurs in April and May when, with the onset of the southeast monsoon, they are transported from the Java Sea into the southern China Sea. In June, water with a higher salinity (>32‰) enters from the east into the Java Sea and, thence farther north up to the southern China Sea, reaching its maximal westward penetration in September. With the onset of the northwest monsoon, in October/November, these water masses are pushed back again towards the Java Sea, while their salinity is reduced by the start of the rain. Salinity in the Java Sea drops below 32‰, reaching its minimum in May, when river runoff from Borneo is maximal.

A steady southeast current flows from the Sunda Shelf through the Malacca Strait into the Indian Ocean. During the northeast monsoon, this current transports relatively high salinity water from the South China Sea. During the southeast monsoon, the water transported is of low salinity, due to river runoff from Central Sumatra and direct rainfall. Strong tidal currents cause a complete vertical mixing over the water column.

Inferences from the COADS Dataset

Extraction and presentation of the data extracted from the Comprehensive Oceanographic and Atmospheric Dataset (COADS) dataset (Woodruff et al. 1987), recently published as a set of five CD-ROMs through the Climate and Eastern Ocean Systems (CEOS) project (Bakun et al. 1992), were used to document the seasonal and interannual variations of SST, of scalar wind speed and the north-south and east-west component of the pseudo wind-stress in six selected areas defined on Fig. 2. The COADS database contains the surface weather observations collected by merchant ships and other platforms (buoys, weather stations, lightships, etc.) since 1854. The data distribution and density in the area are presented in Fig. 3. Data density was, in the 1950s, low all over the region, except along trade lanes such as that passing through the Malacca Strait to Singapore. Later, data density increases along the eastern part of the China Sea but remains "spotty" over the western part of Southeast Asia.

For the purpose of this study, the Java Sea is separated in two areas, eastern and western (see Fig. 2). Other areas defined in Fig. 2 are the southern part of the China Sea, the northern and central parts of the Strait of Malacca, and the Sunda Strait.

For each parameter and each area, a time-series of monthly mean values from 1950 to 1990 was built using the individual observations extracted from the COADS database. A mean annual cycle was derived from the monthly time-series. A time-series of the mean annual value was then calculated and used to characterize the interannual variability from 1950 to 1990.

Variability of the Sea Surface Temperature

SSTs are high all year round in the six areas, with minimum values (27.5°C) observed in January and February in the southern part of the China Sea (Fig. 4). Maximum values are comprised between 29.2°C (Sunda Strait) and 29.8°C

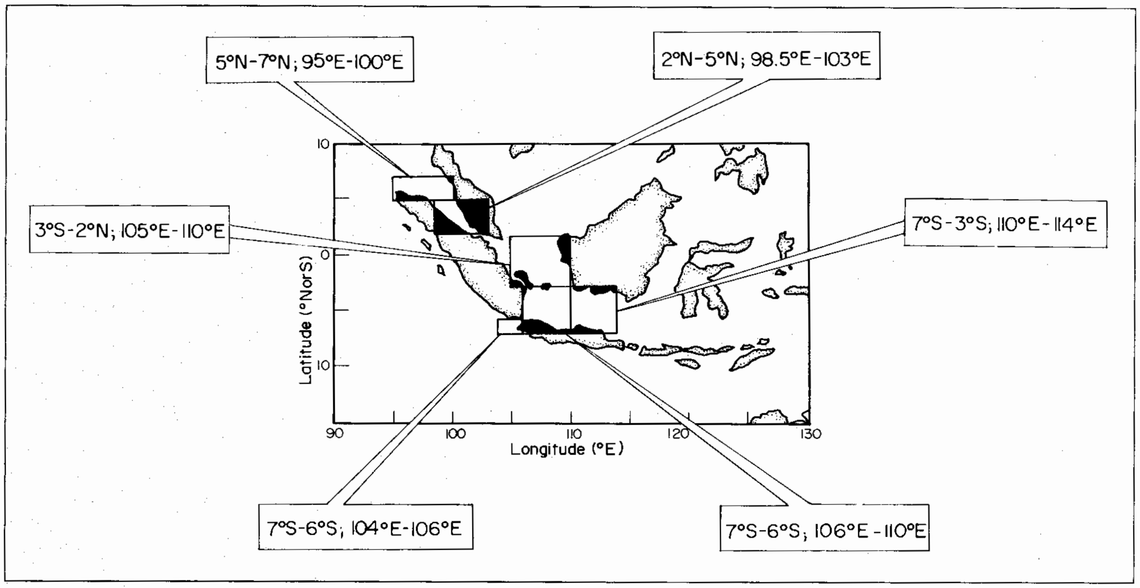

Fig. 2. Definitions of the six areas of Western Indonesia used to structure this contribution (clockwise from the upper left corner): (i) northern Malacca Strait; (ii) central Malacca Strait; (iii) southern South China Sea (including Karimata Strait); (iv) eastern Java Sea; (v) western Java Sea; and (vi) Sunda Strait.
[Gambar 2. Pembagian enam daerah Indonesia bagian barat sebagai dasar penyusunan tulisan ini (searah jarum jam dari pojok kiri atas): (i) Selat Malaka bagian utara; (ii) Selat Malaka bagian tengah; (iii) Laut Cina Selatan bagian selatan (termasuk Selat Karimata); (iv) Laut Jawa bagian timur; (v) Laut Jawa bagian barat; dan (vi) Selat Sunda.]

(Malacca Strait). In some areas located on or south of the equator (Sunda Strait, Java Sea and southern part of the South China Sea), there is a pronounced biannual cycle with a first SST minimum in January-February and a second in August-September.

The amplitude of the SST interannual variability is less than 1.0°C in the Malacca Strait but it increases toward the south (Fig. 5). The greatest amplitude is recorded in the Sunda Strait where it almost reaches 1.5°C. The eastern and western Java Sea, the southern tip of the China Sea and the Sunda Strait all exhibit a similar interannual variability, with mean annual SST values above the average at the end of the 1950s (a feature that may be associated with the 1957-1958 El Niño Southern Oscillation [ENSO] event). SSTs below average appear to have occurred both during the mid-1960s and 1970s. The 1980s, on the other hand, has higher than average SSTs. Major ENSO events (1957-1958; 1972-1973) are associated with a relative peak in SST except for the 1983-1984 event which is nevertheless considered as the most intense of this last century.

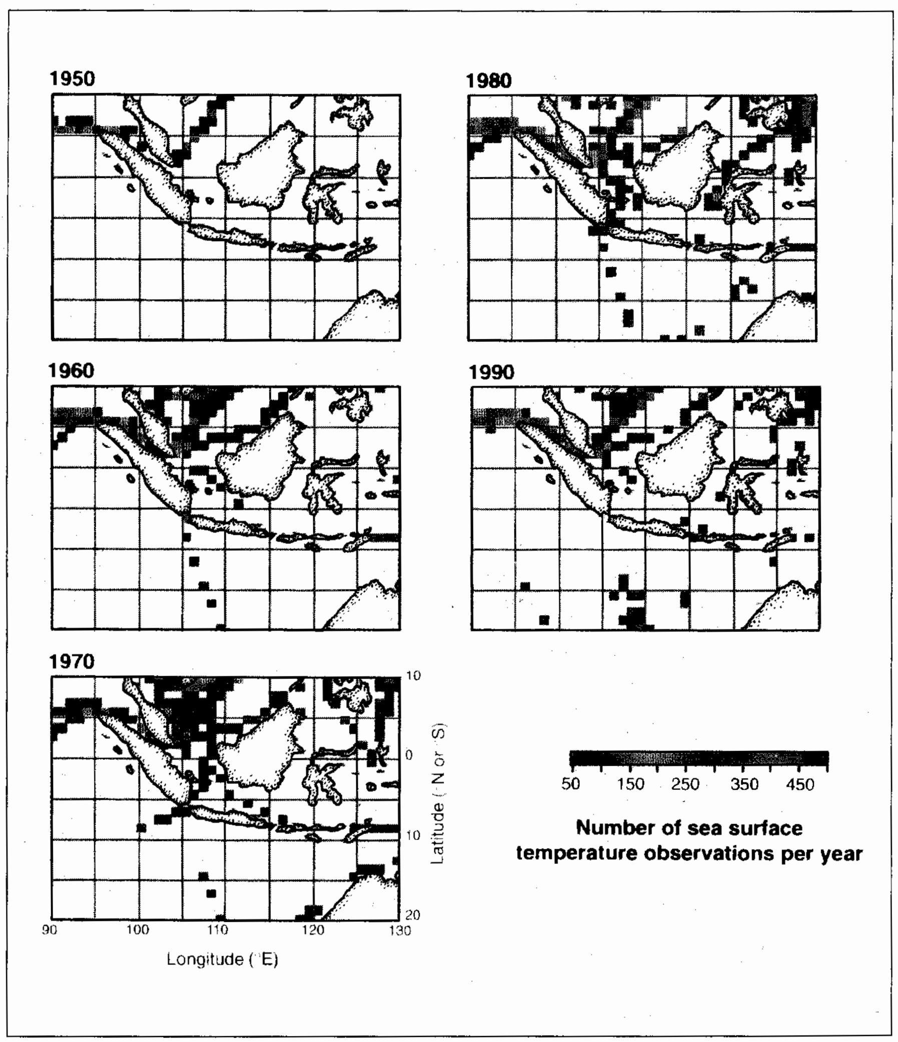

Fig. 3. Data density in the COADS (by selected years: 1950, 1960, 1970, 1980 and 1990). Note that data density is high only along commercial routes and very scarce in the open ocean.
[Gambar 3. Kepadatan data COADS (menurut tahun: 1950, 1960, 1970, 1980 dan 1990). Perlu disimak bahwa kepadatan densitas data tertinggi terdapat di sepanjang daerah pelayaran niaga dan sangat sedikit terdapat di laut bebas.]

Variability of the Wind

The monthly seasonal cycles of the scalar wind speed (i.e., the mean of the two wind

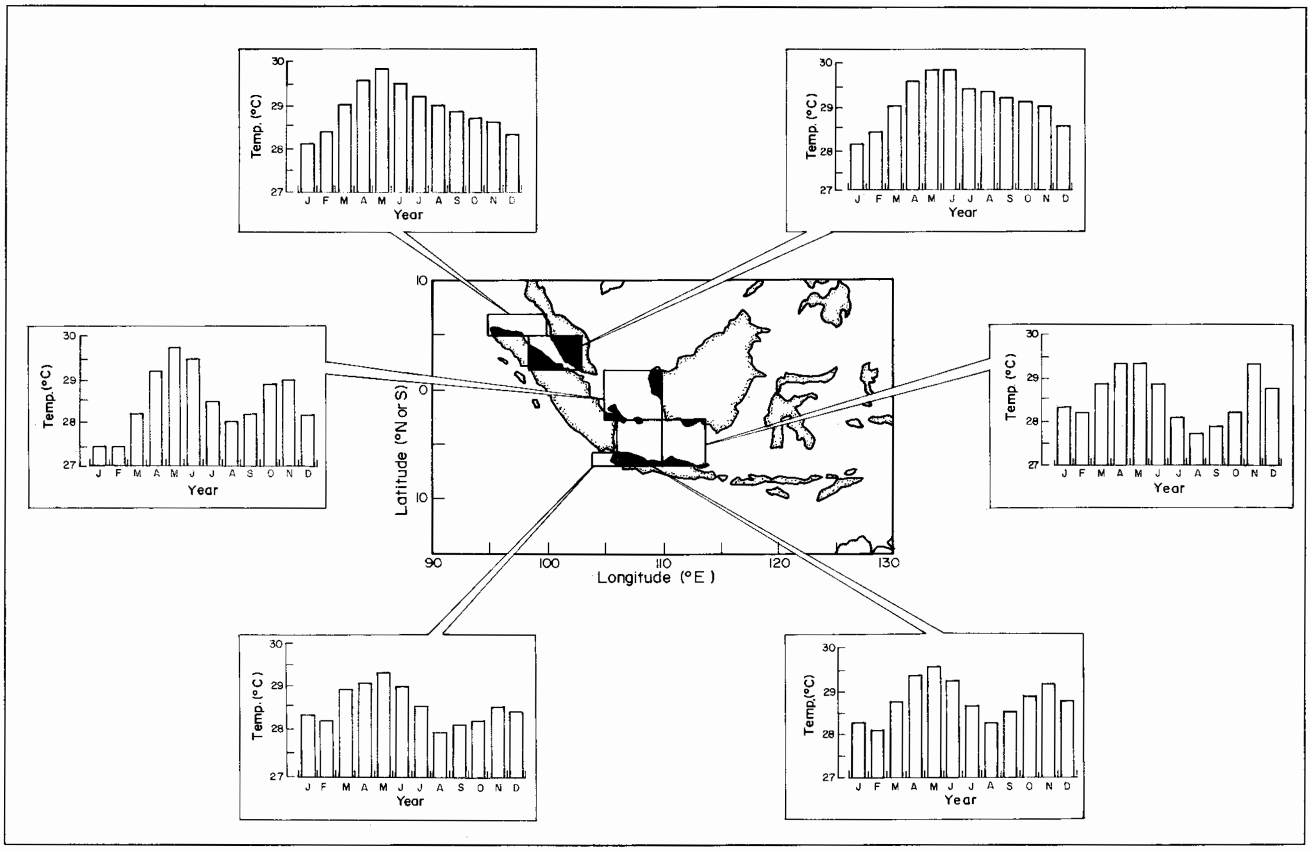

Fig. 4. Mean monthly cycle of SST in six areas of Western **Indonesia.**
[Gambar 4. Siklus bulanan rata-rata SST di enam daerah perairan Indonesia bagian barat.]

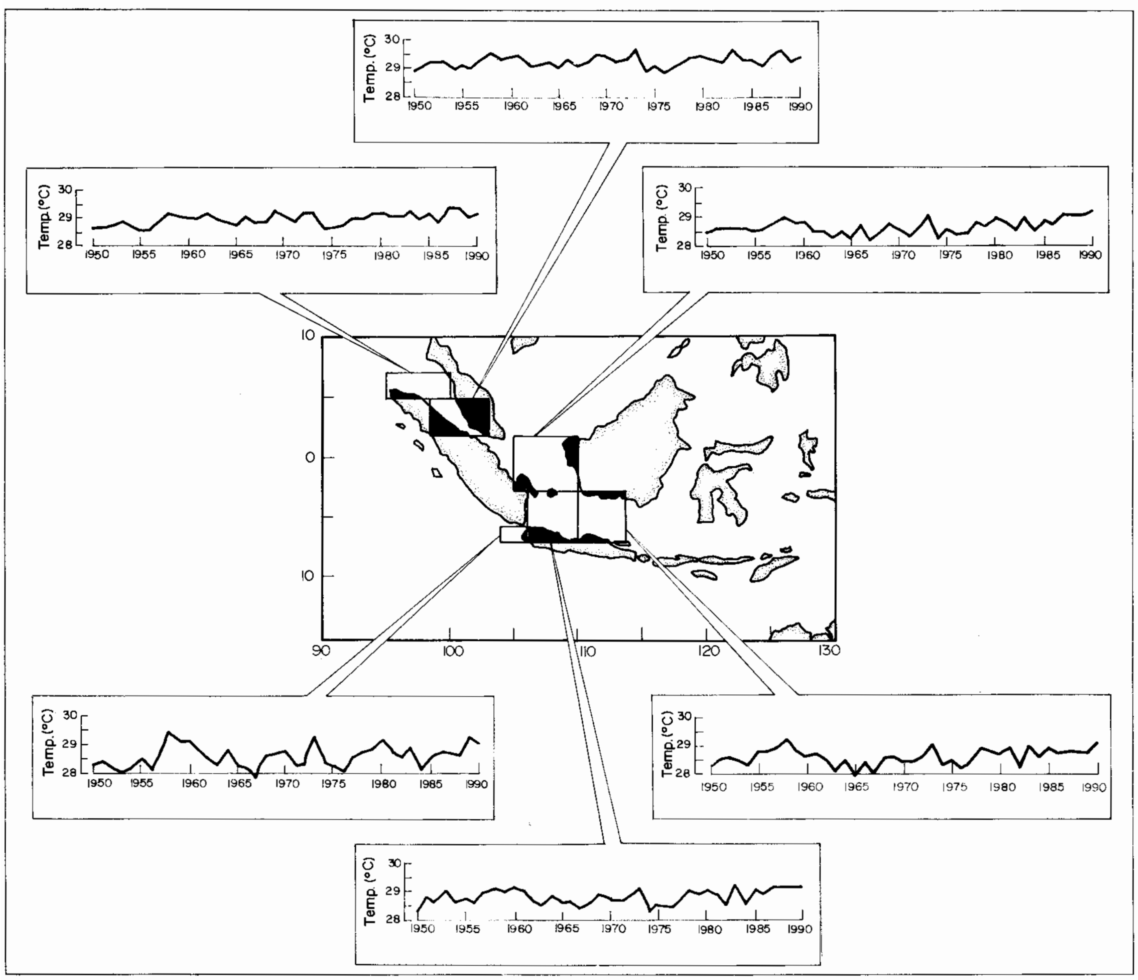

Fig. 5. Mean annual values of SST from 1950 to 1990 in six areas o Western Indonesia (COADS dataset).
[Gambar 5. Rata-rata tahunan SST dari tahun 1950 hingga 1990 di enam daerah perairan Indonesia bagian barat (data COADS).]

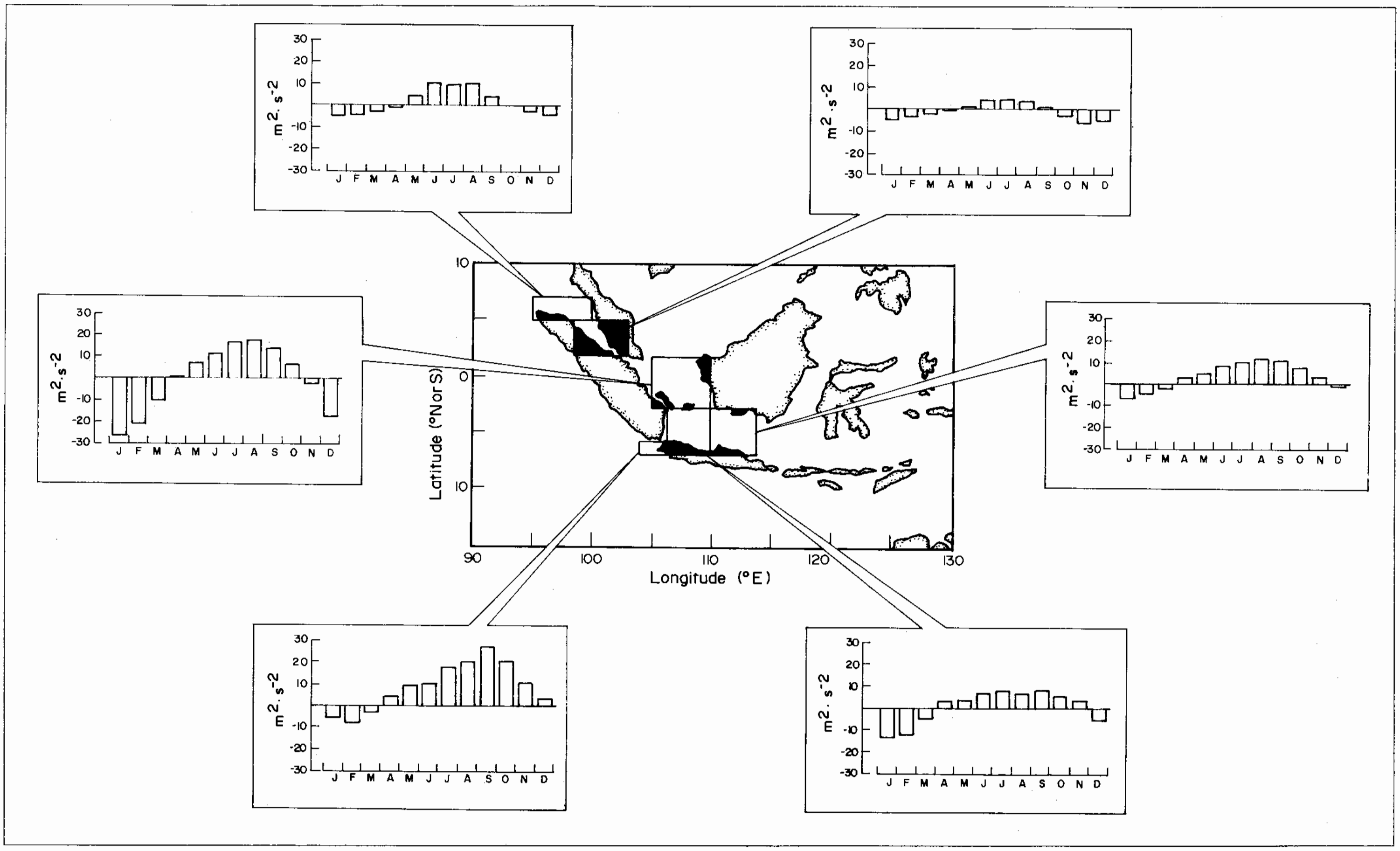

Fig. 6. Mean monthly cycle of the scalar wind speed in six areas of Western Indonesia (COADS dataset).
Gambar 6. Siklus bulanan rata-rata dari kecepatan angin di enam daerah perairan Indonesia bagian barat (data COADS).]

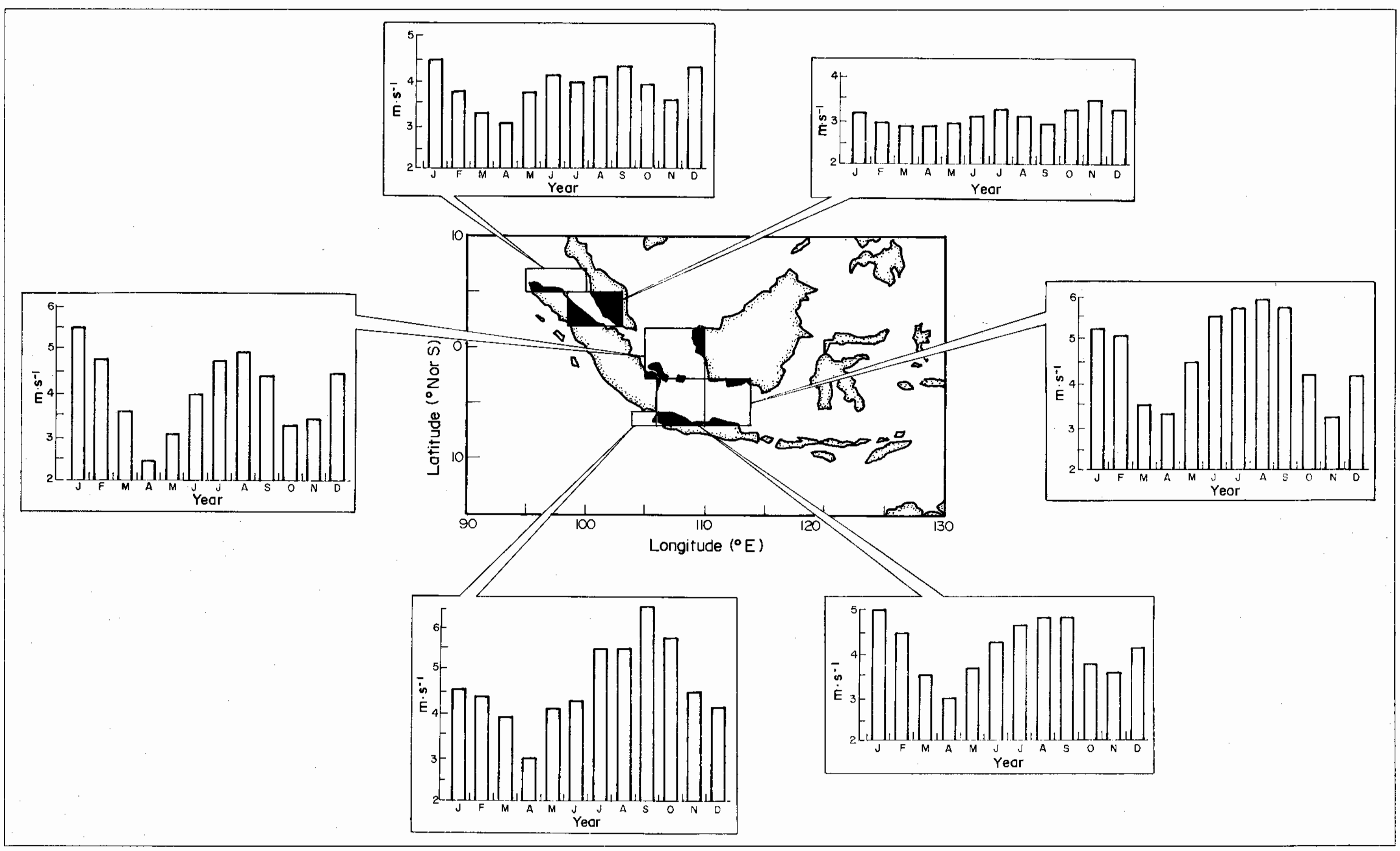

Fig. 7. Mean monthly cycle of the north-south pseudo wind stress component in six areas of Western Indonesia (COADS dataset).
[Gambar 7. Siklus bulanan rata-rata dari komponen pengaruh angin pseudo utara-selatan di enam daerah perairan Indonesia bagian barat (data COADS).]

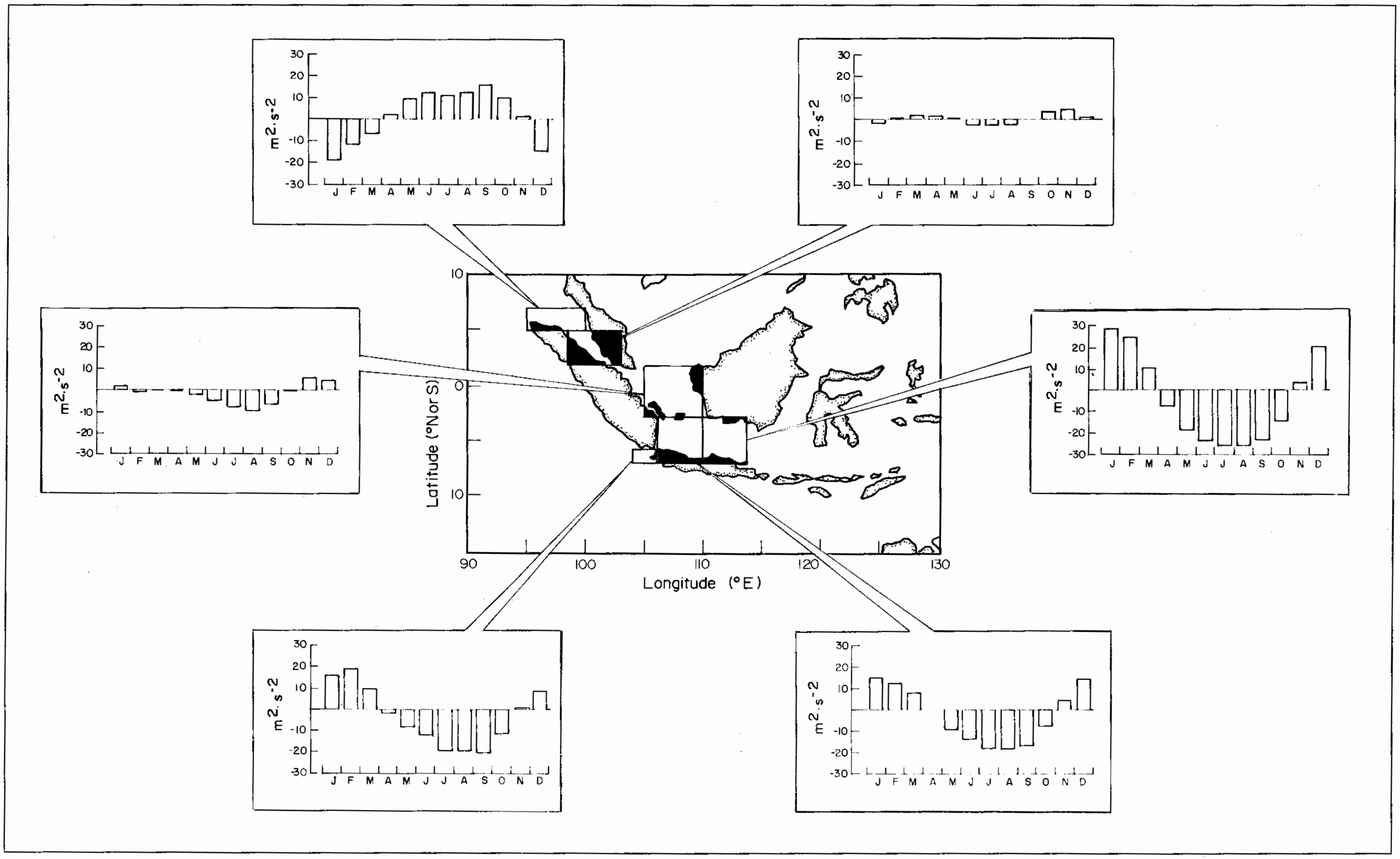

Fig. 8. Mean monthly cycle of the east-west pseudo wind stress component in six areas of Western Indonesia (COADS dataset).
[Gambar 8. Siklus bulanan rata-rata dari komponen pengaruh angin pseudo timur-barat di enam daerah perairan Indonesia bagian barat (data COADS).]

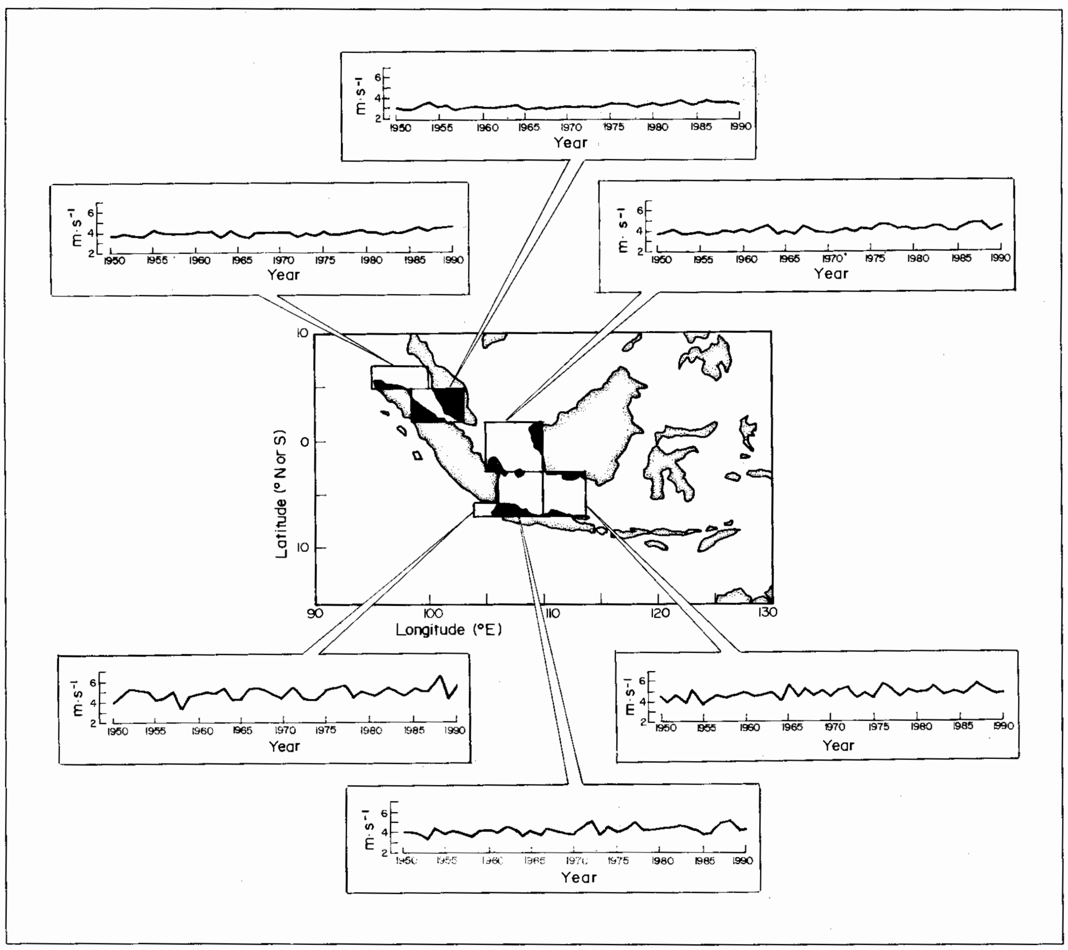

Fig. 9. Mean annual values of the scalar wind speed from 1950 to 1990 in six areas of Western Indonesia (COADS dataset).
[Gambar 9. Nilai rata-rata tahunan kecepatan angin dari tahun 1950 hingga 1990 di enam daerah perairan Indonesia bagian barat (data COADS).]

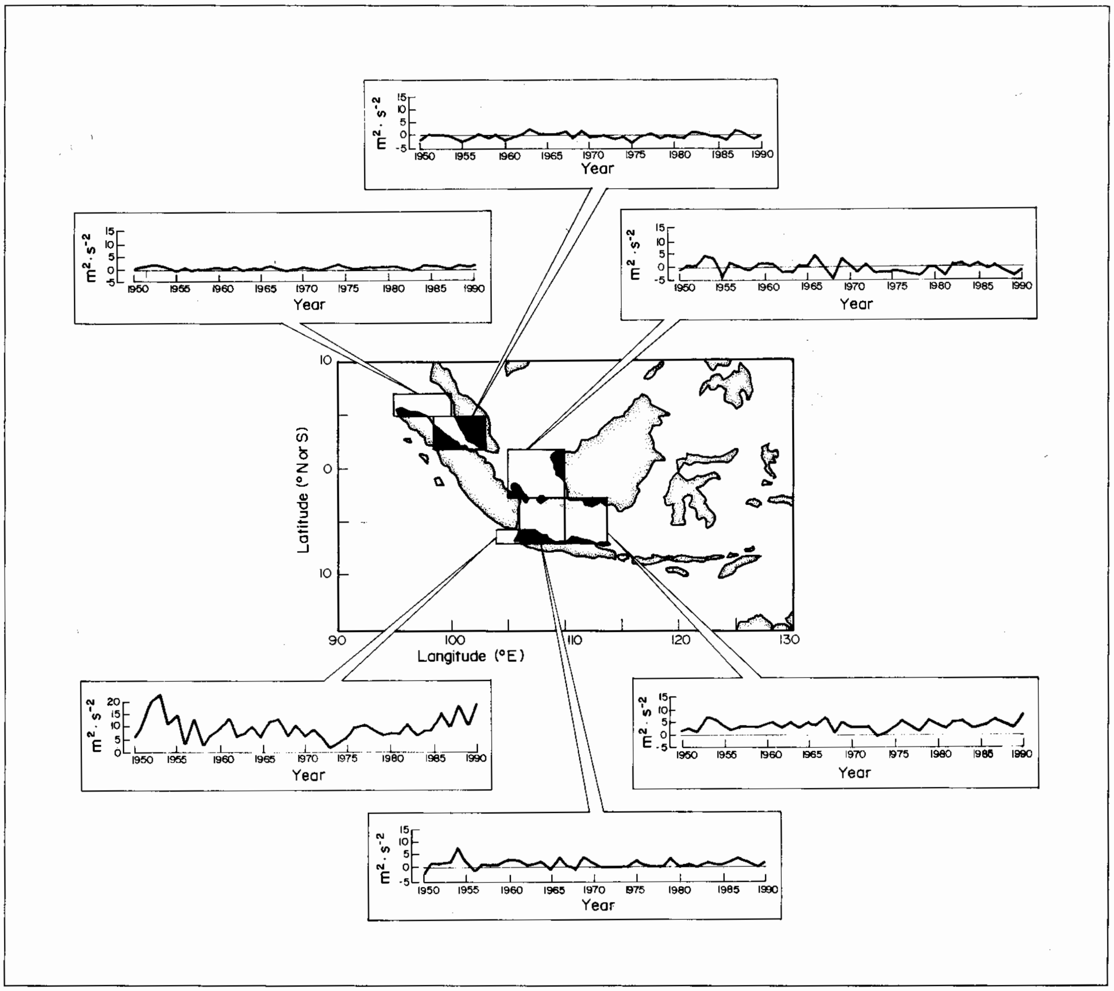

Fig. 10. Mean annual values of the north-south pseudo wind stress component from 1950 to 1990 in six areas of Western Indonesia (COADS dataset).
[Gambar 10. Nilai rata-rata tahunan komponen pengaruh angin pseudo utara-selatan dari tahun 1950 hingga 1990 di enam daerah perairan Indonesia bagian barat (data COADS).]

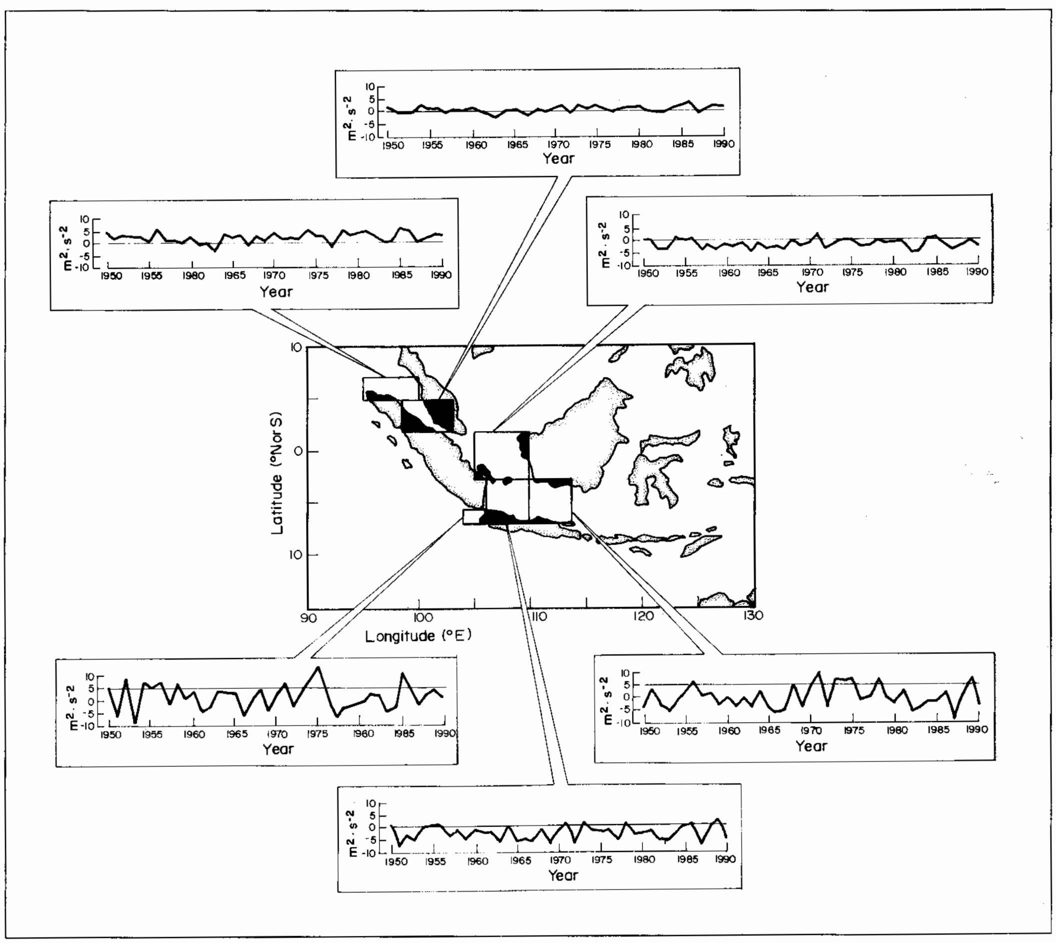

Fig. 11. Mean annual values of the east-west pseudo wind stress component from 1950 to 1990 in six areas of Western Indonesia (COADS dataset).
[Gambar 11. Nilai rata-rata tahunan komponen pengaruh angin pseudo timur-barat dari tahun 1950 hingga 1990 di keenam daerah perairan Indonesia bagian barat (data COADS).]

components) and of the two components of the pseudo wind stress (i.e., squares of the north-south and east-west wind components) are presented in Figs. 6, 7 and 8, respectively. The minimum values are observed in the southern part of the Strait of Malacca (3.5 ms^{-1}); maximum values occur in the Sunda Strait. A marked biannual cycle, due to the monsoon, appears in the southern part of the China Sea, in the Java Sea and in the Sunda Strait areas. Maximum values occur in January and August, while minimum values, in April and November-December. The maximum values stay below 6 ms^{-1} except in the Sunda Strait. This suggests that biological processes may not be dominated by hydrodynamic factors related to the wind (Therriault and Platt 1981; Cury and Roy 1989). The seasonal behaviour of the two wind stress components clearly illustrates the strong alternation (and reversal) of the wind regime due the dynamics of the monsoons (Figs. 7 and 8).

The interannual variability of the wind is rather small in the northern and central Malacca Strait (0.5 ms^{-1}) but increases toward the south (Figs. 9, 10 and 11). The mean annual scalar wind speed exhibits in almost all areas a positive long-term trend. Except for this trend, no clear pattern of variability is readily identifiable: ENSO events do not appear to affect local wind variability. Also, the interannual variability of the two components of the pseudo wind stress exhibits a behavior similar to the variability of the scalar wind.

Conclusion

The previous considerations lead one to conclude that the marine habitats of the adjacent areas to the Indonesian Archipelago are quite unique in the world: the imbrication of land and sea creates complex systems where local processes may prevail over global dynamics. Also, the monsoon regime creates such a strong seasonality of the characteristic of the environment that the alternation of the north and south winds completely reorganizes the surface circulation; this can be expected to have a strong ecological impact. Interannual variability exists, but surprisingly, it appears not to be closely associated with ENSO events - at least, no strong anomalies in either SST or wind appear in the COADS dataset that can straightforwardly be linked with ENSO events. This begs the question whether the complexity of the Southeast Asian environment may have led to some sort of homeostasis.

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The Marine Fisheries of the Western Archipelago: Towards an Economic History, 1850 to the 1960s

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BU the Western Archipelago: towards an economic history, 1850 to the 1960s *[Perikanan laut di* *auan sejarah ekonomi, dari tahun 1850 hingga tahun 1960an]*, p. 24-39. *In* D. Pauly and P. of biodiversity: the fish resources of Western Indonesia. ICLARM Stud. Rev. 23, 312 p.

Abstract

This chapter describes the changes that took place in the marine fisheries of the Western Archipelago between about 1850 and the 1960s. About 1850, most fishing took place close to shore; passive gears such as fishing stakes were predominant in many areas; a large proportion of fish was dried or salted; and fishing oriented to production for the market occurred only in areas near large concentrations of population. In the late 1800s, fishing underwent a commercial revolution, as demand for fish grew both because of the growth of cities and the rapid expansion of mining and plantation agriculture and because of improvements in transportation. Along both sides of the Straits of Malacca, Chinese, employing fishing methods long used by Malays, responded to this demand on a large scale, particularly at Bagan Si Api Api, where the holder of the salt monopoly leased from the Netherlands Indies government provided fishers with relatively cheap salt. At the same time, the fishing communities of Trengganu, making use of cheap salt from Siam, greatly increased production. In contrast, in Java, where salt provided by the government's own monopoly was far more expensive, there was little if any increase in production. Instead, Java became a large importer of fish not only from Bagan Si Api Api but also from Siam. To increase production, the colonial authorities in both Malaya and the Netherlands Indies experimented with large trawlers but with no success. In the meantime, Japanese, working with motorized fish carriers and employing a new method of capturing reeffish, came to dominate the fish markets of Batavia and Singapore, while Chinese operating purse seiners from motor vessels greatly increased production in Malaya. In the aftermath of World War II, the primary concern of all governments was to restore production quickly in order to meet severe food shortages. Motorization and the adoption of nets made of synthetic fibers took place first in Malaya and then in Indonesia. In 1965, a few fishers in Malaysia, following the lead set by Thailand, began fishing with otter trawls in the Straits of Malacca, and soon this fishing method spread to Sumatra and then to Java.

Abstrak

Tulisan ini menggambarkan perubahan-perubahan yang terjadi pada sektor perikanan laut di kawasan kepulauan bagian barat antara tahun 1850 dan 1960an. Sekitar tahun 1850, penangkapan pada umumnya dilaksanakan di daerah dekat pantai; alat-alat tangkap pasif seperti jermal mendominir banyak daerah; sebagian besar ikan dikeringkan atau digarami; dan kegiatan penangkapan bertujuan untuk memasok pasar yang dekat dari daerah pemukiman penduduk. Pada akhir tahun 1800an, perkembangan penangkapan ikan mengalami perubahan pesat sejalan dengan situasi pasar, dimana permintaan akan ikan meningkat akibat pesatnya pertumbuhan perkotaan, perkembangan kegiatan pertambangan dan perkebunan; disamping juga karena kemajuan transportasi. Sepanjang wilayah pantai di kedua sisi Selat Malaka, para nelayan keturunan Cina dengan menggunakan cara penangkapan ikan yang sudah biasa dilakukan oleh para nelayan pribumi Malaya, berusaha memenuhi permintaan situasi pasar dalam skala besar, khususnya di daerah Bagan Si Api-Api, dimana pemegang monopoli garam dari pemerintah Hindia Belanda memberikan harga garam relatif murah kepada para nelayan. Pada saat yang bersamaan, masyarakat nelayan di Trengganu, menggunakan garam yang murah dari Siam, yang mana ini merangsang percepatan produksi ikan. Sebaliknya di pulau Jawa, dimana garam dimonopoli oleh pemerintah harganya sangat mahal, sehingga tidak merangsang kenaikan produksi. Oleh karena itu Jawa menjadi importir ikan terbesar tidak hanya dari Bagan Si Api-Api tetapi juga dari Siam. Dalam rangka meningkatkan produksi, pemerintah kolonial di Malaya dan Hindia Belanda mengadakan percobaan dengan trawl yang besar tetapi tidak berhasil. Sementara itu, orang-orang Jepang yang dilengkapi dengan kapal-kapal penangkap ikan yang menggunakan motor serta dilengkapi dengan alat tangkap baru untuk ikan karang mendominasi pasar di Batavia dan Singapura, sedangkan para nelayan Cina dengan pukat cincin (purse seine) dan kapal motornya benar-benar meningkatan produksi ikan di Malaya. Setelah Perang Dunia II, yang menjadi perhatian utama pihak-pihak pemerintahan adalah berupaya menjaga produksi guna memenuhi kurangnya bahan pangan. Motorisasi dan pemakaian jaring dari bahan serat sintetis dimulai di Malaya dan selanjutnya berkembang di Indonesia. Pada tahun 1965, beberapa nelayan dari Malaysia, mengikuti gerak nelayan Thailand, mulai menangkap ikan dengan otter trawl di Selat Malaka yang kemudian menyebar ke seluruh perairan Sumatra dan Jawa.

Introduction

The seas of Southeast Asia have long provided coastal vellers with a multitude of riches ranging from fish, shrimps id whales to pearl oysters, *tripang* and seaweed. People have collected and captured marine life for food, medicine, oil, jewelry, and a great variety of other uses. The purpose of this chapter is to trace and explain the changes that took place in fishing in the Western Archipelago from about 1850 to the mid-1960s, when trawling was rapidly adopted as one of the main fishing methods. The focus will be on the capture of finfish, but some attention will have to be devoted to that of shrimps as well, for there has often been a close relationship between the two fisheries. It is useful to begin this survey in the middle of the nineteenth century with an overview of fishing in what I shall call the "Western Archipelago" corresponding to what are now Malaysia and Western Indonesia (Fig. 1). We must keep in mind though that such an approach carries the danger of ignoring important changes such as the development of fishing techniques that had taken place over many centuries. Box 1 defines some of the local terms used here.

Economic History

Fishing about 1850

In 1850, the Western Archipelago had a population of about twenty million, concentrated in the islands of Java and Madura, the highlands of west Sumatra, the Straits Settlements, numerous small harbor towns along the coasts of Sumatra, the Malay Peninsula, Borneo, and in isolated mines and plantations. For virtually all of these people - whether the overwhelming majority who produced at least part of their own food or those few who lived in towns or worked in mines and plantations here and there - fish was a staple food. "Fish along with rice is the main ingredient of [the Javan's] meal" (Anon. 1882). Nearly always fish was consumed after it had undergone some form of preservation, almost always by drying, salting, or some combination of the two, for there was no other way of preserving fish in the hot, humid climate. Dried fish was, observed Crawfurd (1820), "an article of as universal consumption among Indian islanders as flesh is in cold countries." Even fishers consumed at least part of their fish intake in this form, since for most of them there were times of the year when there were few fish or when the weather prevented them from catching them. Also important in the diet of the people of the Western Archipelago was shrimp or fish paste, called *terasi* by the Javanese and known as *belacan* to the Malay-speaking peoples of the archipelago, "the universal sauce of the Indian islanders", without which "no food is deemed palatable" (Crawfurd 1820).

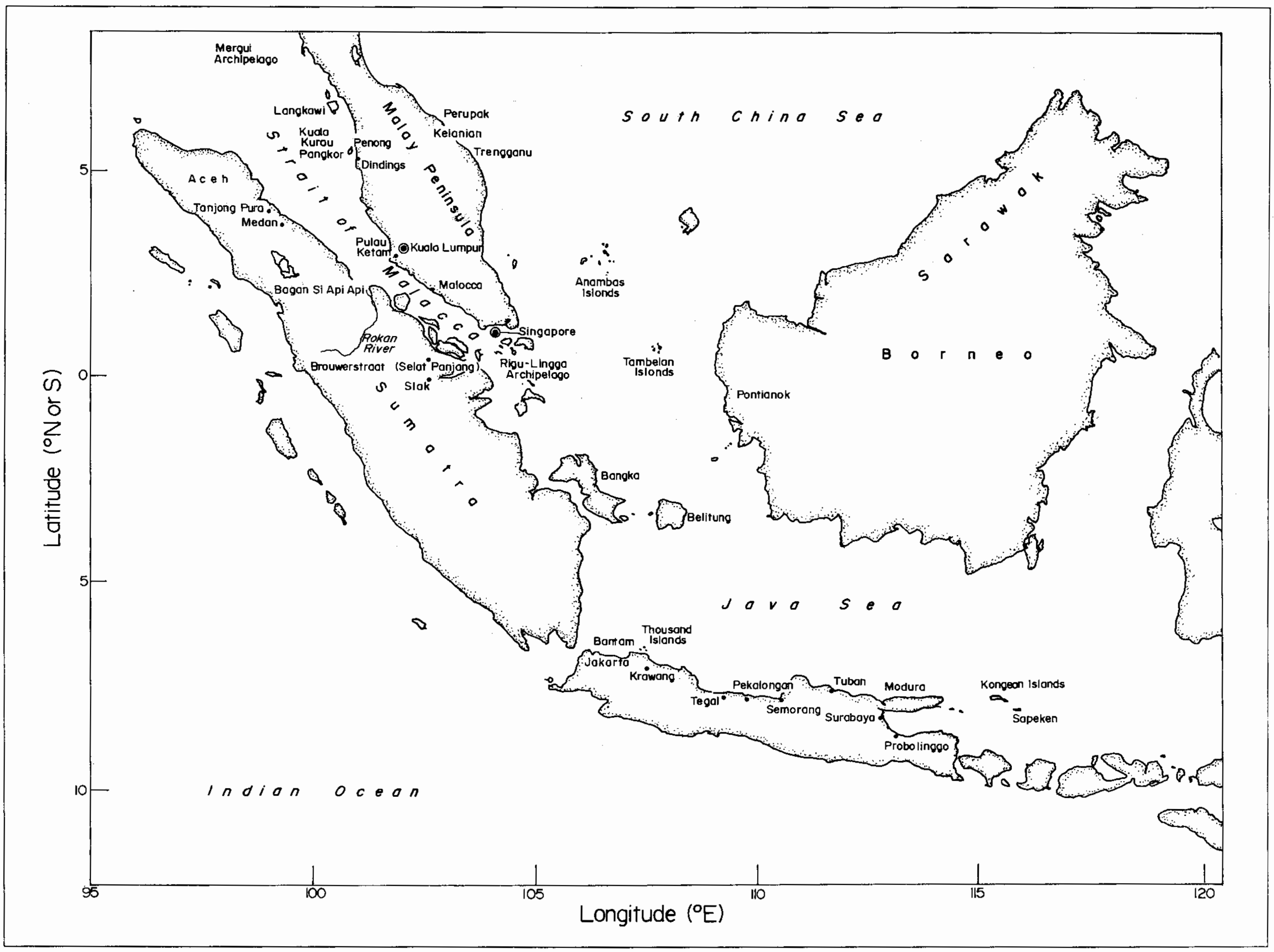

Fig. 1. Map of the Western Archipelago, showing all locations mentioned in the text.
[Gambar 1. Peta kepulauan bagian barat yang menunjukkan beberapa lokasi penting sebagaimana disebutkan dalam tulisan.]

Box 1. Definition of some non-English terms used in the text.
[Boks 1. Penjelasan beberapa istilah lokal yang dipakai di dalam tulisan ini.]

ambai	-	fishing stake consisting of two converging wings of poles which guide shrimp into a trap made of a fine-meshed net at the end of which is placed a pocket of coarse sacking.
belacan	-	fish or (more usually) shrimp paste.
bubu	-	generic term for a variety of portable fish traps set on the seabed.
jermal	-	large fishing stake consisting of two converging wings of poles and an enclosure into which fish and shrimps are swept by the current and from which they can be extracted by lifting a large rattan screen.
kongsi	-	a business group.
muro ami	-	drive-in net set on reef slopes and used for capturing fusiliers (Fam. Caesionidae) and other reeffish.
payang	-	seine net used in conjunction with a fish lure in the *layang* fishery of Java Sea.
prahu mayang	-	offshore fishing boat, usually operating a *payang* to catch *layang* and other pelagic species.
rumpon	-	floating fish lure used in catching *layang*.
sero	-	fishing stake made up of a series of successively smaller chambers through which fish move until captured in the smallest chamber.
si stji	-	fishing stake similar to *jermal* but much smaller and easily moved from one place to another.
tendak	-	fish lure.
terasi	-	Javanese word for *belacan*.
towkay	-	Chinese businessman.
towkay bangliau	-	the head of a group of (Chinese) fishers, as at Bagan Si Api Api.

The importance of fish to nutrition took many forms. For most people, fish was almost their only source of animal protein, for meat was eaten only on special occasions. It also supplied them with calcium (for tiny dried fish were eaten whole, i.e., their skeleton was consumed as well), iodine and various other essential nutients. But most of the inhabitants of the Western Archipelago consumed fish in fairly small quantities, or at least that is the impression given by numerous references to what people ate at this time, as in this description of a meal in a Malay house in Malacca:

> Cooking operations are simple, for the meal usually consists of boiled rice, small pieces of dried fish heated over the embers of the fire, and a concoction of hot red chillies that have been ground with salt into a paste. The smoking rice is put in the centre of the floor; pieces of dried fish and fiery chillies, ground up with salt are the usual relishes, and around this simple fare the family sit with their legs crossed (Rathborne 1898).

And in this more general report from the 1880s:

> Where meat is almost unobtainable, or if obtained is coarse and uneatable, the dried salt fish is the only article of food to be relied upon, and, so far as my experience goes, it is both palatable and nourishing. It is soaked and cut up into small dice, and fried until quite brown. *A small quantity of this mixed with boiled rice* makes a dish, which Chinese, Malays and Europeans seem equally to relish (Tenison-Woods 1888; emphasis added).

It appears that the consumption of fish per capita was particularly low in parts of Java. There, *terasi* made an important contribution to people's diets not because it is rich in protein, for it was consumed in tiny quantities, but because its use as a condiment stimulated the consumption of unpolished rice and soya products, their main sources of protein.

The fish and shrimp people ate came from rivers, lakes, paddy fields and irrigation canals, fresh- and brackishwater ponds specially constructed for the cultivation of fish, and most important of all, the sea. It is probably safe to say that fish and shrimp captured from the sea made up a slightly smaller proportion of the total intake in the middle of the nineteenth century than they did in the early 1900s, by which time many inland waters had been polluted or silted up as a result of human activities and (as will be seen) sea fisheries had expanded greatly. Nevertheless, the sea was by far the biggest source of the fish and shrimp people consumed.

We can safely assume that the seas of the Western Archipelago were blessed with an abundance of fish at this time. Certainly that is the impression conveyed by contemporary reports. "No part of the world abounds in more fine fish", declared Crawfurd (1820). "The seas of the western parts of the Archipelago particularly the Strait of Malacca, and the shores of the Gulf of Siam, are the most remarkable for their abundance of edible fish." Along the west coast of the Malay Peninsula, wrote Anderson (1824), "fish of the choicest and most delicate description is extremely abundant," while along the east coast, according to Clifford (1897), "the fish crowd the shallow shoal waters, and move up and down the coast, during the whole of the open season, in great schools acres in extent." And an Englishman who sailed along the west coast of Borneo in the 1820s commented that "the coasts and rivers abound with excellent and wholesome fish in the greatest variety, and of the most delicious flavours" (Moor 1837). We have to treat these accounts with caution. European observers may have exaggerated the abundance of the marine life of the Western Archipelago just as they did the fertility of the soils. Nevertheless, reports about the abundance of fish in very specific locations certainly confirm the impression given by these accounts. At certain times in the Brouwerstraat (Selat Panjang), "the movement near the surface of a solid mass of fish, consisting almost entirely of spawners, produces a choppy rippling of the water" (Anon. 1882). Abdullah (1970) recalled that when the British arrived at Singapore in 1819 "fish were very plentiful and large ones were found close to shore." Moreover, it is worth noting that the "abundance" of fish at this time was determined mainly by the ability of people to catch them, not by the number actually present in the sea. Thus, no one could have had much of an appreciation of the abundance of demersal species, those pelagic species moving about far from shore, and those fish (notably fusilier, Fam. Caesionidae) living above reef slopes. There were, in short, many niches remaining to be explored and exploited.

Except along the south coast of Java and the west coast of Sumatra, where fishing was generally confined to sheltered bays because of rough seas and steep cliffs, people engaged in the work of catching and processing fish all along the coasts of the Western Archipelago. The extent to which they devoted their lives to fishing, however, varied greatly from one part of the archipelago to another. In some areas, fishing was the main livelihood for many people. Veth (1875) noted that all along the north coast of Java "one finds a number of kampongs whose people devote themselves almost exclusively to fishing" and that this was even more so in Madura, "for whose population fishing is a chief means of support." In communities such as these, almost all work was related in one way or another to fishing, the women often looking after processing and marketing while the men fished or repaired boats and nets. In some other areas fishing took place only during certain months of the year, as in Sarawak:

> Large fishing establishments are found at the mouths of all the principal rivers during the southwest, or fine monsoon; the fishermen usually leaving them during the northeast, or boisterous monsoon, and returned to the town, where they pursue other avocations until fine weather again brings the shoals of fish to their shores (Low 1848).

In many other areas fishing was an intermittent activity, pursued when people needed fish for their own consumption or when they did not have to tend their crops, as in Sumatra, "where fishing is a separate occupation in only a very small part [of the island]" (Anon. 1882).

Here a striking pattern becomes evident, and that is that the places where fishing was people's primary livelihood tended to be quite near large concentrations of population, particularly cities and other places such as mines and plantations where there were large numbers of people who did not produce their own food. In short, as a rule, fishing villages engaged in production for nearby markets. Thus, the fishing villages of Madura and the north coast of Java produced fish mainly for the large towns and huge rural population of Java, while the Chinese fishers along the west coast of Borneo caught fish both for the nearby towns such as Pontianak and for the gold miners of the interior. This pattern was a reflection both of the nature of transportation at this time - slow and unreliable - and the fact that fish could generally be caught in sufficient quantities within a relatively short distance of markets. There were, of course, exceptions to this pattern. The most notable was the *trubuk* fishery of the Brouwerstraat, but it is worth noting here that it was the expensive roe, not the whole fish, that was carried to markets around the archipelago, just as *tripang* and sharks' fins were shipped to China and mother of pearl to China and Europe at this time.

The fishers of the Western Archipelago employed a great range of ingenious methods to capture fish. These included many different kinds of fishing stakes such as the *sero* and the *jermal*; a variety of traps, widely known as *bubu*; an enormous variety of nets operated from shore as well as from boats; different techniques using hook and line; and many other methods such as harpooning and the use of stupeficants. Looked at from today's vantage point, it is notable that a very large proportion of the fish caught in the Western Archipelago at this time was caught by means of fishing stakes:

> This way of fishing is so important that in some parts of Java it far surpasses net fishing, for example, in Meester Cornelis in the Residency of Batavia and in the part of Surabaya bordering the Madura Strait, where the amount of fish caught by any other means is in comparison completely insignificant (Anon. 1882).

The prevalence of such "passive" devices was in no way an indication that fishing methods were "undeveloped" at this time but rather that large quantities of fish could usually be caught without chasing after them.

One of the most striking features of fishing at this time was its rhythmic nature, oscillating according to the hour of the day, the phases of the moon and the seasons of the year, all of which had a bearing both on the presence of fish and on the ability of fishers to catch them. Of crucial importance for many fishers was the daily alternation of the land and sea breezes:

> Nearly everyday one can see the *prahu mayang*... push off from shore at three or four in the morning in order to cast their nets. The land wind carries them quickly out of sight, but at noon they prepare to make use of the sea wind for their return trip, which brings them back to shore at two o'clock, often with a full load (Veth 1875).

Many forms of fishing were regulated by the phases of the moon, though with great variation from place to place depending both on the behavior of the fish and the method being used to catch them:

> ... in Tapanuli fishing at night takes place only during a dark moon, whereas, in contrast, at Tanjong Pura (East Coast of Sumatra) it takes place during the full moon *(pasang besar)* and the first quarter and last quarter (*pasang mati*), while in the Brouwerstraat fishing is considered the most favorable during the new and full moons (Anon. 1882).

Almost everywhere the rhythm of fishing had a seasonal nature, both because certain fish, notably pelagic species, were more abundant at certain times of the year and because during certain months the strong monsoon winds made fishing too dangerous. Thus, during the three or four months when the northeast monsoon made fishing impossible, the fishers of Trengganu "build and repair their boats and houses, make and mend their nets, do a little planting, and generally pass the time in performing odd jobs" (Clifford 1895).

Despite the existence of these regularities, it is essential to keep in mind that uncertainty and risk were always a part of fishing. Migratory fish did not always arrive at the time and place they normally did. If the sea breeze did not start at the expected time the morning's catch would spoil before the *prahu* could reach shore. A day's catch could be lost if the boat overturned in the breakers. A sudden storm might capsize a boat and drown all on board. Even operating a fishing stake exposed those who worked on it to "dangers from stray sharks, sawfish and crocodiles, from the deadly sea-snakes, from many kinds of medusae, from fish with venomous fins, from stinging-rays and torpedo-fish" (Wilkinson et al. 1904). These uncertainties and dangers may explain why taboos and rituals were an important part of fishing.

Mention must be made of the role of states at this time. Most fishing probably took place without the help or hindrance of state powers. In fact, one of the dangers faced by fishers (and discouraging people from going to sea) was the absence of control over pirates and slave raiders. Nevertheless, in some places state authorities did impose taxes and monopolies that affected the livelihoods of fishers. The sultan of Siak demanded that the *trubuk* fishers hand over first part and later all of their catch at prices well below market values, while the Dutch imposed licence fees when they assumed control over his domain. And in Java the Dutch subjected fishing to various taxes as well as a government monopoly over the production and sale of salt, which may be why in Java so little use of salt was made when drying fish (Veth 1875). In light of present-day debates about regulating access to the sea it is worth referring to a report from the 1920s that "the sea next to the north coast of Java is mutually divided by the villages into districts, where each has erected its own *tendak*. Customary law [*adat*] has thus created a right of ownership" (Schippers 1928). It is not clear to me, however, whether this was an ancient practice or one that developed as the number of fishers increased during the nineteenth and early twentieth centuries, nor is it clear what role if any state authorities had in promoting or supporting such arrangements.

An issue of central importance about which I have little information concerns the financing of fishing at this time. A survey of sea fishing in the Netherlands Indies published in 1882 makes it clear that fishing stakes, boats and nets often cost a great deal to buy or construct, but it gives little idea of how this money was raised. With respect to Java, the survey often refers to the "owners" of boats and gear, indicating that the owner almost invariably captained the fishing team, and describes the often elaborate ways the proceeds from catches were distributed among owners and crews, but it gives no hint of whether owners used their own funds (perhaps the accumulated profits of earlier fishing) to buy boats and gears or whether they borrowed money to buy them (Anon. 1882). It is only when Chinese fish traders were involved that the survey becomes more specific, as in this comment about the *trubuk* fishery of the Brouwerstraat:

> ... the trade is entirely in the hands of foreigners, namely, the Chinese buyers, who often have the fishers completely in their control by giving them advances, completely regulate the market price of the product, and take the biggest profit. The increase in price that *telor trubuk [trubuk* roe*]* undergoes makes it often unobtainable for the ordinary native and more of a special dish than a daily dessert (Anon. 1882).

The fact that the trubuk fishery produced a high cost product for long distance trade may mean that this situation was far from typical, but this needs to be explored.

The Commercial Revolution

Beginning about 1870, the production of fish products began to increase dramatically in several parts of the Western Archipelago. We must see this change in the context of the political and economic transformation taking place at this time. In the 1850s, the Dutch began incorporating (by force in the case of Aceh, by treaty in many other places) more and more of the region into the Netherlands Indies until, by the early twentieth century, it covered the areas closely corresponding to present-day Indonesia, while the British extended their control over the Malay Peninsula in stages from 1874 to 1910. This extension of colonial authority was accompanied by (and financed by) a rapid expansion in economic activity, as first Chinese and then European entrepreneurs opened up mines and plantations, particularly in the Malay Peninsula and Sumatra. In Java, there was a big expansion in sugar production, and the population of the island continued to grow. Also significant was the growth of Singapore, Penang, Batavia, Surabaya, Semarang, Medan and many smaller towns. These changes had a profound impact on fisheries in the Western Archipelago. The market for fish skyrocketed both because there was an enormous increase in the number of people who now had to buy fish (or had it bought for them, in the case of mine and plantation workers) and because steamships could now transport fish products (mainly salted fish and *belacan*) fairly cheaply over long distances. What took place is best described as a commercial revolution because of the vast increase in production for the market and because of the development of an elaborate system of financing, processing, and marketing. It certainly was not a technological revolution, since little change took place in fishing techniques. What occurred was a spectacular expansion of fishing using existing methods.

Although fishers throughout the Western Archipelago took part in this expansion, the degree to which they responded to the new opportunities varied considerably. We can demonstrate this by looking at three areas: the Strait of Malacca, Trengganu and Java.

The most rapid expansion took place along the coasts of the Straits of Malacca. Beginning about 1860, small groups of Chinese (referred to as former pirates in some sources) began settling at many spots along the straits. Along the eastern side of the straits, Chinese set up fishing villages at Kuala Kurau, Pangkor and Pulau Ketam. Along the western side, the most important area was the estuary of the Rokan River, where

Chinese founded the village of Bagan Si Api Api. All of these fishers adopted Malay fishing techniques; those fishing along the eastern side supplied fish to Penang and the rapidly growing mining population of the interior, while those at Bagan Si Api Api may have shipped what they produced across the Straits to Malacca as well as possibly up the Rokan River. At first no ruler or government exerted much authority over these villages, but by the 1880s the colonial states had exerted enough control to force them to pay taxes.

The most spectacular growth in production took place in the Rokan estuary, a place which was extraordinarily rich in marine life but which was not even mentioned in the 1882 survey of fishing in the Netherlands Indies. In 1898 (the first year for which there is a figure), Bagan Si Api Api already exported 12,700 t of dried fish; in 1904 it exported 25,900 t of dried fish and 2,700 t of *belacan* (Haga 1917). There were several reasons for this spectacular increase. To begin with, there was the extraordinary abundance of fish in the estuary. The organic matter continually being brought from the interior of Sumatra by the Rokan River, the constant mixing and oxygenation of the water taking place because of the tidal bore, and the dense mangroves all contributed to the growth of many species of finfish and shrimps.

Just as important, however, was the way fishing was organized to produce for the market. The fishers themselves were organized into small *kongsis*, each headed by a *towkay bangliau*, who provided the capital equipment needed to undertake the business and fed and gave the fishers cash advances. Up to the early 1900s, fishing was almost entirely conducted by means of *jermals*, which were placed in the estuary in such a way that fish were driven into them on the outgoing tide. The fish immediately underwent a preliminary salting on board the boat bringing the fish to shore; once on shore the fish were placed on extensive platforms to dry. The *towkay bangliau* paid the fishers a share of the proceeds from the sale of the fish to local fish traders, Chinese from Java, once they had deducted their expenses and their own share.

The linchpin for the whole business was the salt farm, which supplied the vital ingredient needed to preserve fish to be shipped long distances. Unlike in most other parts of the Netherlands Indies, where salt had to be bought at very high prices from the government's salt monopoly, the government leased out the exclusive right to sell salt at Bagan Si Api Api. This monopoly or farm was held by a syndicate made up of prominent Chinese businessmen on both sides of the straits. The important point here is that up to about 1905 this syndicate held the farm with little or no competition from rival syndicates and that therefore the rent it had to pay to the government was low. This meant that the farm was able to sell salt - cheap, good quality salt bought in Singapore, but which had been shipped from Aden across the Indian Ocean - to the fishers at a price well below that prevailing in those parts of the Netherlands Indies subjected to the government's monopoly. The farm could, of course, have raised the price of salt but apparently chose not to in the expectation that a low price would stimulate production. Since the rent that the syndicate owning the farm had to pay the government was fixed for the term of each contract, whatever was collected over and above that rent could be kept. In order to promote production still further the salt was supplied on credit to the *towkay bangliau*. As well as receiving credit, the *towkay* received cash advances from the fish traders. Thus, there was an elaborate system of credit, backed up by a powerful syndicate, that lubricated the expansion of production. As well as supplying credit, the syndicate owning the farm was connected with a shipping line that carried the fish to Singapore and Java. The result, according to Colijn (1905), the first Dutch official to report on Bagan Si Api Api, appears to have been "a good livelihood for the fishers, a great profit for the [Netherlands Indies] treasury, and, certainly, a gold mine for the farmer".

Although the main market for the salt fish produced at Bagan Si Api Api was Java, this fish had to compete with fish imported from Siam (and Cambodia) via Singapore as well as locally produced fish, though to a much less extent, for reasons to be explained shortly. The summary report of the Welfare Commission comments that the imported fish "is transported from the bigger harbors to the interior. On the south coast one finds Siam fish in the most remote *desas*" (Hasselman 1914). In general the consumers of Java preferred "Siam fish", which consisted of *kembong* (*Rastrelliger* spp.) preserved in a great deal of salt (in fact some of this salt could be reused, which was part of the attraction of the product), to the *ikan busuk* ("rotten fish") of Bagan Si Api Api and were therefore prepared to pay a higher price for it. As a result, the price in Java of fish produced in Bagan Si Api Api was largely determined by the supply to Siam fish, which meant that when there was a big supply of Siam fish the price of fish from Bagan Si Api Api fell.

Between 1904 and 1910, exports of dried fish from Bagan Si Api Api fell from 25,900 to 18,900 t. Just why this occurred is unclear, but we should note that three things were happening simultaneously: the farm raised the price of salt, the estuary was silting up and the many years of intensive fishing were having at least some effect on stocks, as evidenced by the fact that far fewer large fish were being caught than had been a few years earlier. In their often bitter debates about the causes of the decline (*achteruitgang*) of Bagan Si Api Api, Dutch officials tended to focus on one or another of these factors. Most blamed the rising price of salt. Although they argued that, thanks to a big increase in competition for the farm from rival syndicates, it now paid a much bigger rent to the government and so had to recoup its costs by selling salt at a higher price, it is worth noting that the farm might still have made a profit by keeping prices low and thereby promoted production still further. That it chose not to do this may have been because it may have no longer been possible to keep pushing up production as in earlier years. Most officials pointed out that the silting up of the estuary - the extension of the shore of this part of Sumatra - had been going on for thousands of years, but it is possible that the process had speeded up because of the large-scale cutting of mangroves for the poles needed to construct *jermals* as well as cutting of trees upstream for the construction of houses and drying platforms in the town. It is also possible that the cutting of mangroves, combined with prolonged, intensive fishing (Gobee [1912] reported that the *jermals* "stood close together" in the inner part of the estuary, catching "everything carried out with the ebb tide"), was having an effect on fish stocks. In short, I am suggesting that these circumstances may have given the farmer little choice but to increase the price of salt to try to meet his obligations to the government. However we might explain the "decline", we can at least say that, as the price of salt went up, the fishers began to use less salt when preserving their catches and that as a result the reputation of fish from Bagan Si Api Api began to fall. Moreover, the rising price of salt seems to have encouraged the production of *belacan*, for which less salt is needed in relation to the value of the product. In the early 1900s, fishers began interweaving split rattan into the interstices of the rattan screen used in *jermals* and placing sacking behind the screens so that their *jermals* could catch the tiny shrimp used to make *belacan* as well as the larger ones, which were dried. Soon after that they began fishing with another Malay device, the *ambai*, which they used specifically for catching shrimp. Between 1904 and 1909, exports of *belacan* jumped from 2,700 to 10,100 t, while those of dried shrimps rose from 400 to 1,200 t. (Although the fishers were putting much more effort into catching shrimp, it is possible that the capture of huge quantities of finfish had resulted in less predation on shrimps [see Pauly 1982, 1984; Pauly and Mathews 1986] and that therefore there also were more shrimps to be caught, at least in the first few years.) After 1909, even exports of *belacan* fell somewhat, apparently because the traders who prepared it were skimping on salt, the price of which continued to rise.

The story of the fishing industry of Bagan Si Api Api in the 1910s is extremely complex. In brief, the syndicate tried to collect the huge sums it had lent the fish traders; many of the traders were unable to pay up and went bankrupt; a new syndicate took over the farm, making a profit until the government clamped down on some of their surreptitious impositions and the price of salt on the world market went up because of the shortage of shipping in World War I; and the Dutch government, sick of the debates about Bagan Si Api Api and eager to get rid of this farm and similar ones (by this time the great opium farms of Java had been replaced by a government monopoly), arranged for salt to be sold by a company made up of local traders. It is notable that after 1920 exports again rose, as the price of salt fell somewhat, a moveable trap, the *si stji*, was introduced, thus getting around the huge cost involved in building new *jermals* whenever the water in which they stood silted up, and fishing with drift nets further out in the straits became an important part of the industry. In the 1920s and 1930s, Bagan Si Api Api was still the leading fishing port in the Western Archipelago and, for that matter, one of the biggest in the world.

Another place producing for export, though on a smaller scale than Bagan Si Api Api, was Trengganu on the east coast of the Malay Peninsula. Here fishing was performed using a big variety of nets, since fishing stakes could not be used on the east coast except where they could be protected from the northeast monsoon by placing them on the lee side of an island. Fishing and the processing of the catch were conducted entirely by the Malays of Trengganu - the men went to sea, while the women salted and dried what the men caught - but the Chinese controlled the marketing and export of the fish after processing. The key institution was the farm for the right to collect the export duty on dried fish, virtually all of which was shipped to Singapore. (In the early 1930s, it was reported that the fish produced in Trengganu and shipped to Singapore was sent on to Java [Anon. 1932]. This pattern may have been in place for a long time.) At this stage I can say nothing about the connection between the Chinese who held this farm and those who bought dried fish and shipped these to Singapore, but it is likely that in order to increase profits (as exports went up all the profits collected could be kept as long as the rent to the sultan was paid) they lent money to the traders and that they in turn advanced money to the fishers on the understanding that they would be able to buy their catch. In any case, production increased rapidly in the late nineteenth and early twentieth centuries. In 1910, the value of exports of fish - the most important export of the state - was (Straits) $464,000, roughly equivalent to 2,500 t of dried fish; by 1914, the value of exports had climbed to $781,000 (Shaharil 1984). An important factor in the steady increase in production was access to cheap salt produced in the salt pans of the inner part of the Gulf of Thailand. Malay traders carried *belacan*, also made in great quantities in Trengganu, to Siam and returned carrying salt.

Bagan Si Api Api and Trengganu were the two largest exporters of dried fish in the Western Archipelago. At Bagan Si Api Api the *towkay bangliau* had nearly all fallen by the wayside by about 1914 and the fishers (who had prospered even as the farmer and the traders had gone under) owned and operated their own stakes and boats. As far as I can tell, no one owned several stakes and hired people to work them. Similarly, along the coast of Trengganu, noted Clifford (1895), "owners of boats and nets usually take an active part in the fishing operations; and the capitalist who owns many crafts and lives on the income from their hire is almost unknown."

Fig. 2 provides a rough picture of the trade in dried fish, *belacan* and salt about 1910. A number of things are worth noting. First, an extensive trading system had developed by this time, largely in the previous thirty years. Second, much of the salt needed to sustain the growth in production in the Western Archipelago came from Arabia and Siam. And, third, although the plantation and mining districts of Sumatra and Malaya imported large quantities of fish, by far the biggest importer of fish (and *belacan*) was Java.

This last point brings us to a brief look at Java. Although a huge quantity of fish and *belacan* was being imported into Java, the case of fish imports from all sources amounted to only about 1.5 kg per person per year, which probably was a fairly small proportion of average consumption. Nevertheless, the fact remains that the Java Sea contained more than enough fish to meet the demand in Java. During the late nineteenth

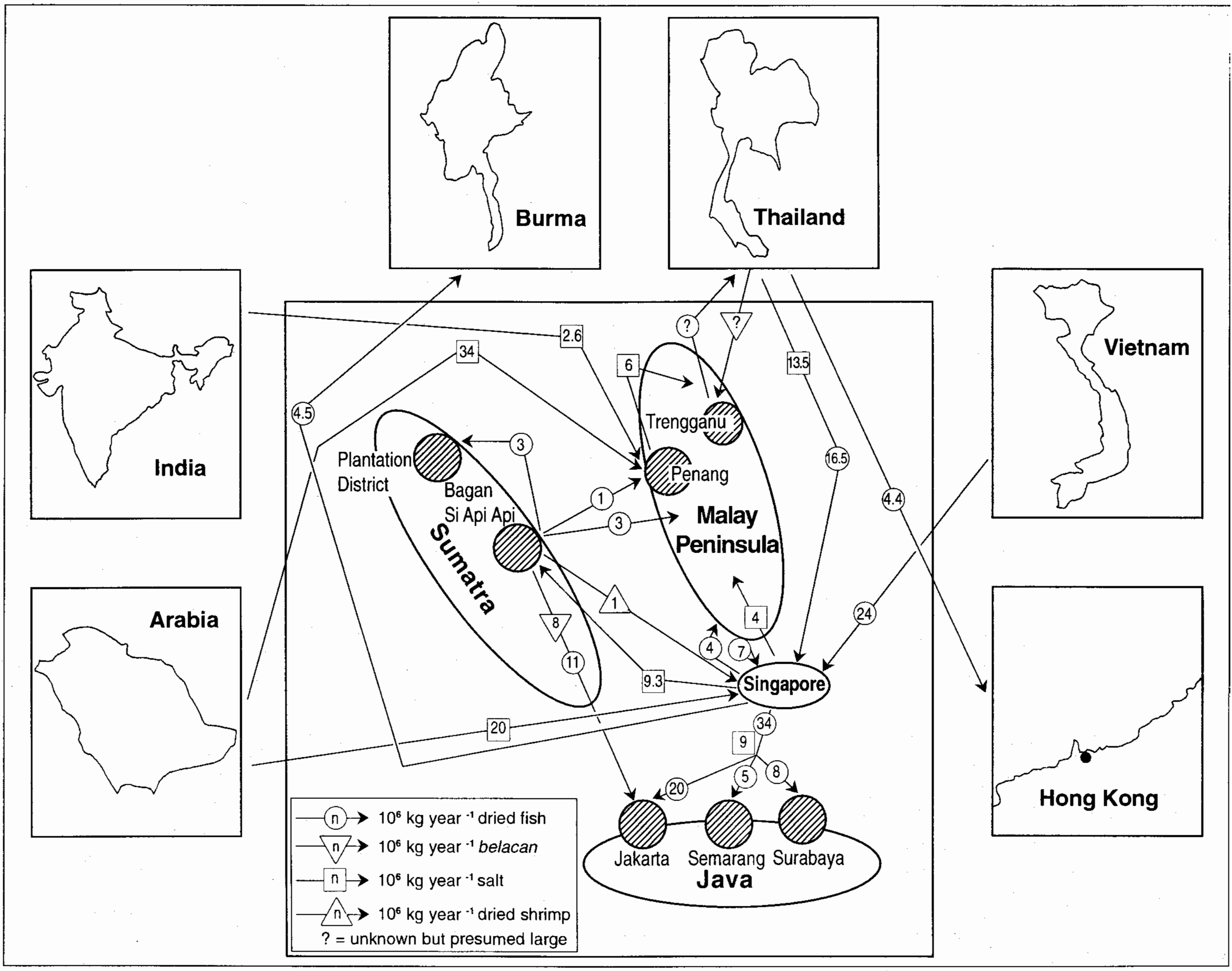

Fig. 2. Trade in dried fish, *belacan* and salt *ca* 1910 (Butcher 1992).
[Gambar 2. Perdagangan ikan asin, belacan dan garam sekitar tahun 1910 (Butcher 1992).]

and early twentieth century, production in Java appeared to have increased at no more than (perhaps slightly less than) the rate at which the population grew. That it did not increase faster to meet the rising demand was the result of several factors, of which I will mention two associated with the preservation of catches. First, the *layang* fishers did not carry salt with them when they went out to sea, for a variety of reasons. According to the government's "Welfare Commission", the fishers of Tuban did not do so because there was not enough room on board their boats for salting fish, and those of Pekalongan had a "superstition" that stopped them from taking any salt to sea, while those of Probolinggo claimed that fish avoided nets that, because of the lack of space on their boats, had come in contact with salted fish stored on board (Anon. 1905a). Whatever the reason, the fact that the fishers did not salt their catches on board greatly hindered the expansion of production:

> Because fish are not salted on board, they must be sold as quickly as possible, especially where transport is poorly developed. The result is that on long trips the fish are already sold while underway, that a brief but frantic trade takes place at the landing places, and that the market is quickly oversupplied and, when there are very large catches, the fish are sometimes unsaleable (Hasselman 1914).

Even more important was the high price of salt. The Javanese had developed a variety of techniques of preserving fish by simply drying them or by using salt-laden beach sand, but these were not very effective in preparing a product that would not be consumed within a very short period. In the early 1900s the colonial authorities, caught up in the liberal spirit of the "Ethical Movement" and desirous of increasing the supply of fish to the growing population of Java, introduced a system of salting sheds at which fishers (at least those living nearby) could preserve their catch using salt supplied by the government monopoly. Although the salt sold at these sheds was very much cheaper than that sold to ordinary consumers, the price was still much higher than it was in Siam and the fishers were prohibited from taking the salt with them to sea, which of course limited the time they could spend catching fish, though this rule appeared to have been relaxed in a very small number of places by about 1920. One of the effects of the system of salting sheds appeared to have been that the men took over work that had been carried out by the women, at least that is what is implied in a comment by one critic that "it is extremely desirable that the women be able to remain at home salting [the fish] while the men are at sea" (Schippers 1928).

Just how restrictive the government monopoly was is illustrated by the case of Sapeken in the Kangean Islands. Up to the early 1900s, there was a thriving fishing industry there, thanks largely to the availability of cheap salt imported from Makassar. The government knew of this trade but turned a blind eye to it (Anon. 1905). In 1907, however, it prohibited the use of Makassar salt and forced the people of Sapeken to buy salt from the government monopoly. Following this clampdown, "fishing came to standstill; there were shortages because there were no fish with which to pay for the necessities of life, all of which Sapeken must import; many left the island and set up elsewhere, the population of Sapeken village falling from 6800 to 3700 people" (Van der Plas, in van Kampen 1922). When the government set up salting sheds at Sapeken, fish exports rose but not to the pre-1907 level.

During the 1920s and 1930s, the process of commercialization continued and more and more fishing became oriented to production for the market. R. Firth's sketch of the economic history of a Kelantan fishing village before he did his fieldwork there in 1940 provides a unique insight into some of the forces behind this process. According to Firth (1975), the construction of a road linking Perupok with the main population center of Kelantan "altered the fishing economy considerably", as it made possible a regular bus service, which created a market for fresh fish, for which the fishers were able to get much higher prices than the fish they sold for drying. More people took up fishing; whereas fishing had remained a subsidiary activity for many people "the life of the fishermen became more completely divorced from agriculture"; and money rather than barter transactions became the rule. "The life of the community", Firth (1975) concluded, "finally merged much more completely into the general economy of the State". (Bailey 1980, 1983 described a similar impact of road building for another Malaysian village, Mangkok.)

As already suggested, capital and finance were crucial to the whole process of commercialization, for "a good deal of capital... is needed for sea fishing" (Hasselman 1914). Capital was needed to buy boats, nets and fishing stakes, and credit was often needed to cover operating and living costs, particularly because of the seasonal and often unpredictable nature of fishing as a livelihood. There was a great variety of ways in which capital and credit were provided. Some fishers had enough money to buy a boat and the needed gear, and some bought them on time purchase. Gathering together the capital needed to mount an elaborate fishing operation, as in the case of the liftnet fishery described by Firth, was often made possible by pooling the boats and nets of several fishers on the understanding that the catch would be divided up according to how much capital as well as how much labor the fisher had contributed to the operation. Borrowing money to buy capital items as well as to cover operating and living costs was widespread. Almost everywhere fish dealers were the principal lenders, having as they did a vested interest in pushing up the quantity of fish available for them to buy and sell. The nature of these loans varied greatly. At one extreme, generally when a small amount of money was involved, fishers were able to pay off their debts by handing over a proportion of their catch to the dealer for a limited period. At the other, the dealers in fact owned the boats and gear and advanced cash to the fishers, in return for which the fisher was required to hand over all of his catch to the dealer. In general, it appeared that as time went by, as fishers became increasingly oriented to the market, there was a trend towards arrangements of the second type. Referring to the situation in 1940, Firth (1975) made the point that the fishers of Trengganu, where production had long been oriented almost entirely towards the export market, were much more tightly bound by debt to dealer-lenders than were those of Kelantan, where commercialization came later and where a much smaller portion of the catch was exported. The Welfare Commission concluded that many fishers along the north coast of Java "are gradually coming financially completely under the control" of the powerful *kongsis* of Batavia fish traders (Hasselman 1914), who, according to van Kampen (1922):

> ... give advances to the fishers at high interest rates but also at great risk, for if the fishing gear or *prahu* is lost the moneylender... usually loses what he has lent. The debt is settled at the auction at the fish market, which is in the hands of the same *kongsi*. Because they have easy access to credit the fishers are able to maintain their *prahus* and fishing gear properly; the moneylenders stimulate them - in the interests of both - to greater energy and the business progresses. Fishers from Bantam, Krawang, and Tegal come to Batavia in order to fish there with advances from the *kongsis*.

It should be added that many fisheries officers of the time took a much less favorable view of fish dealers. Referring to Malaya, Stead (1923) wrote that:

> In nearly all cases the fisherman is practically "bound" to sell to a specific *towkay*. Not legally so, perhaps, but for all practical purposes there is no escape, as he is in the hands of this *towkay* financially. The *towkay* has probably

> advanced him money for his nets or for his other gear, and has allowed the man to run into debt in other ways, with the express purpose of keeping the necessary hold over him, so that the man will regularly contribute a fish supply to the *towkay.* By getting together a number of such "clients" the *towkay* is sure of his own livelihood.

Sentiments such as these were behind a number of attempts by colonial authorities in both British Malaya and the Netherlands Indies to promote cooperatives and alternative sources of credit for fishing communities in the 1920s and 1930s.

The Beginnings of Mechanization

What Cushing (1988) called "the first industrialization" of fisheries accelerated in the 1890s with the development of the otter trawl. One of the first projects of the Fishery Station set up in Batavia in 1904 was to explore the possibility of introducing the otter trawl and other gears commonly used in the West, apparently on the assumption that fishing would become a Western capital intensive industry just as mining and the cultivation of various crops had over the previous half century. Beginning in 1907, the *Gier,* a 650-t steam vessel, experimented with the otter trawl in the Java Sea, but in 1911 the Fishery Station abandoned the project. One of the main reasons was the nature of the sea bottom, as van Kampen (1922) explained a few years later:

> Where, as in the Java Sea, the sea is not too deep for this fishery, the bottom consists of soft mud, into which the trawl sinks, or of sand, studded with coral, that damages the net with its sharp edges, or the bottom is in fact covered with various lower forms of animals (sponges, sea urchins, and so forth) which by their weight endangers the captured fish and even the net itself. The otter trawl of the research vessel was more than once shredded by meter-high cup sponges.

In the mid-1920s the British conducted similar experiments with the *Tongkol* (292 GT) in the waters off the Malay Peninsula and concluded that demersal species did not exist in sufficient abundance to sustain a trawl fishery, at least at the prices of fish then prevailing. In light of later events, however, an official report pointed out that "large catches can be made by the trawl within the ten fathom line between the Dindings and Penang" and suggested that "small motor-trawlers built locally and manned by Asiatics promise to be highly remunerative in this area" (Anon. 1927).

While the colonial authorities were unsuccessfully trying to industrialize fishing by introducing the otter trawl towed by large vessels, groups of Japanese fishers had introduced a revolutionary new method of fishing, *muro ami.* The movement of Japanese fishers into the Western Archipelago was part of the diaspora of Japanese merchants, photographers, dentists and planters that took place beginning in the late nineteenth century but accelerating after World War I, but it appeared to have been prompted at least in part by increasing pressure on their fishing grounds in the Ryukyu Islands and regulations by the Japanese government closing off certain areas from fishing. In any case, Japanese fishers very quickly made a big impact in "the South Seas". As early as 1921, Maxwell (1921a) noted that the Japanese based at Singapore "catch more than the rest of the local fishermen combined". In about 1925, a group of Japanese had set up in Batavia as well; in the late 1930s, there were three *kongsis*, supplying (by value) about a third of the fish auctioned at Batavia.

A number of aspects of this new form of fishing need to be emphasized. First, the Japanese exploited a new niche, the waters above the slopes of coral reefs. Before the arrival of the Japanese, some indigenous fishers had fished on the reef slopes using traps and spears, but their catches were very small and fusiliers (Fam. Caesionidae), fish that predominated in this niche, had been sold in local markets in very small quantities. In general, nets were not effective on reef slopes - they caught on the coral and rip - but the *muro ami* fishers fixed the net to the sea bottom and frightened the fish into the net. Second, this method of fishing required tremendous strength and skill on the part of the fishers, for they had to dive to the seabed to fix the net to the bottom and then herd the fish into the net by swimming along the surface toward the mouth of the net carrying a long rope to which were attached strips of white cloth and at the end of which was a lead weight. "They are more like fish than men", marvelled a fisheries officer who spent three months watching them at work (van Pel 1938). Third, *muro ami* also required an extremely high degree of organization. This is evident not only in the way the 50 men in a *muro ami* team cooperated in catching the fish but also in the link between the team and the market. While one of the two motor boats supporting each team carried the catch on ice to the market, the other was on hand or on its way to the fishing ground to pick up more fish. A team would stay out for as long as six months at a time while the carriers shuttled back and forth. "No time is left unused and the business operates continously" (Reuter 1940). And, fourth, this business required a great deal of capital. None of the boats in a *muro ami* team was particularly large - a typical carrier was 15 - 20 m long - but the total amount of capital tied up in the carriers, the smaller boats used during fishing and the net was considerable, as was the amount of money needed for fuel, ice, food and other supplies. However, while the amount of capital involved was great and one person might be the sole owner of one or more *kongsis*, there is evidence that at least some owners exercised little direct control over their business. According to Reuter (1940):

> The fishers work for the boat owner as a team, so that he does not deal with them separately but only with one or several team leaders. These leaders enjoy a great deal of

> independence, so that one often gets the impression that in essence the ship owner merely hires his vessels out for a share of the profit. This impression is particularly strong in the case of one ship owner who has a *muro ami* business and has no understanding at all of fishing and often does not know where the boats are operating.

During the 1920s and 1930s, teams of *muro ami* fishers went farther and farther afield in their search for new fishing grounds. Those based at Singapore fished in the Riau-Lingga Archipelago, near the Anambas Islands, up the east coast of the Malay Peninsula as far as the Gulf of Siam, and along the west coast from Langkawi to the Mergui Archipelago, while those based at Batavia scoured the reefs near Bawean and elsewhere in the eastern part of Java Sea, near Bangka and Belitung, and along the west coast of Sumatra. So effective was *muro ami* that even in the mid-1920s some fisheries officers wondered whether it might threaten stocks; however, none of them appeared to have been particularly alarmed. In 1926, the director of the fisheries department in Malaya pointed out the "obvious danger" of overfishing but, while calling for scientific study of the fusiliers, seemed to accept the statements of the *muro ami* fishers that they did not reach the depths where most fusiliers lived and that therefore the areas they fished were constantly being replenished (Anon. 1925). In 1932, a fisheries officer argued that although the *muro ami* teams had found it necessary to go farther and farther from Singapore "because the nearby grounds yielded comparatively only small catches", stocks were not being depleted but rather the fish were learning how to avoid the fishers (Anon. 1932). Van Pel (1938) reported that few fish were left after the *muro ami* team he accompanied had fished all the reefs on the eastern sides of the Thousand Islands, adding matter of factly that reefs were not fished again for two years after a team had been through. None of the reports I have seen said anything about the possible effects the lead weight used by the fishers had on the coral a major source of reef destruction now well documented, e.g., in the Philippines (Corpuz et al. 1983).

In the meantime an important change was taking place in the way fishing was conducted along the west coast of the Malay Peninsula. Up to the 1920s, various forms of fishing stakes caught the great bulk of fish landed along this coast. "The whole of the West Coast... was dotted by" these stakes (Yap 1976). Beginning in about 1920, however, the Federated Malay States (FMS) government introduced regulations that discouraged use of these stakes. Because the stakes were mainly built using poles taken from mangroves the great expansion in the number of stakes had seriously depleted mangrove forests in the area. This pushed up the price of the materials needed for constructing stakes, a trend accentuated when the government closed off certain sections of the forest from cutters. The government also regulated the activities of the stake fishers more closely, mainly in an attempt to protect fish stocks, which officials believed were being undermined by the stakes, outfitted as many were with fine-meshed nets that caught large quantities of immature fish. (Small and immature fish were used either as fertilizer or as food for pigs and ducks.) In 1920 the Perak government banned *ambais* outright. As stake fishing became either less profitable or, in some forms, altogether impossible, a new form of fishing, the purse seine, was introduced at Pangkor. Whether the people who introduced or quickly took up purse seining were the same people being pushed out of the stake fisheries or whether they were relatively recent arrivals from China is unclear to me. What is clear is that these fishers introduced a net "hitherto unknown in Malaya and... never... used by local fishermen". The main target of the fishers was *kembong* (*Rastrelliger* spp.) "both abundant at times, and universally esteemed" (Anon. 1930), which were caught and then either salted and dried or boiled in brine. The main market for these products was the tin mines and rubber plantations of the interior, but some were also sent to Singapore and Penang and then transhipped to "other countries" (almost certainly the Netherlands Indies) - the incentive to produce for an export market was increased sometime during the 1930s when the FMS government abolished the export duty on salt fish.

Up to 1937 the purse seine - a net 170 fathoms long and 28 fathoms deep with a half inch mesh - was taken to sea in 32-meter, long sailing junks, each of which was accompanied by 3 small boats, 2 for operating the net and 1 for helping to locate fish and to convey supplies and the catch. The crew consisted of a captain, 2 helmsmen, 2 expert *kembong* watchers, 11 deck hands, and 1 or 2 cooks, usually wives of the captain. The time when fishing could take place was limited, mainly because the fish could be seen swimming very near the surface only on moonless nights. Catches varied enormously depending on how many fish were present, whether the *kembong* watcher had spotted a big school, and whether the net could be placed without many fish escaping. Beginning in 1937, the scale of operations increased substantially as many owners replaced their junks with boats powered by 12-hp diesel engines. In 1936, there were 11 sailing boats based at Pangkor that engaged in purse seining; by 1938, all of the sailing boats had been abandoned and the fishing was conduced by 32 motor boats (Anon. 1938). Motorization freed the boats of their dependence on the wind, enabled them to cover a much greater area in a shorter time and to return to port every day, and combined with surveys then being conducted by *R/V Kembong*, gave the fishers access to previously unknown fishing grounds. Between 1931 and 1936, landings of *kembong* at Pangkor shot up from about 800 to 5,000 t. The great problem of the business was how to handle gluts, which severely depressed prices. On a poor night a boat might catch as little as 0.3 t, but catches could reach over 30 t a night. As of 1938 little had been done to overcome this problem, but the fisheries department experimented with freezing and canning *kembong*. The purse seine fisheries of Pangkor resembled many present-day fishing businesses, albeit on a much smaller scale. The owner of the boat and net, usually a fish dealer, had overall control over the operation but did not take part in the fishing himself. He paid for the fuel, and he paid the crew partly in the form of wages and partly in the form of a share of the proceeds from the sale of the fish (Anon. 1937).

After abandoning the possibility of a capital-intensive trawling industry, fisheries officers in the Netherlands Indies adopted a new line of thinking, one aimed at the improvement of "native" fishing, which it was believed could only take place without sudden change. In van Kampen's view, many of the gears used by Javanese fishers, most notably the *payang*, worked well as they were; what was needed were motors for the *prahu mayang*:

> Because of the regular alternation of the sea and land winds the fishing prahus as a rule only need to sail before the wind and for this purpose they are excellently designed. However, variable winds, such as prevail during the transition between monsoons, and calm make their use uncertain and are therefore the reason that fish do not reach the shore fresh. Petrol motors as auxiliary power would be very helpful in this respect. At the same time these could be used for hauling in the net, so that the crew could be smaller (van Kampen 1922).

Apparently little if anything was done in this direction during the 1920s, but when he was appointed to take charge of the development of fisheries in the Netherlands Indies in 1927, C.J. Bottomanne set the motorization of *prahu mayang* as one of his primary goals. At first he experimented with gasoline engines but because of the very high tax on gasoline he then experimented with semi-diesel and diesel engines, which were heavier and more expensive. In West Java, this experiment appeared to have been more successful than in other parts of Java. There, by 1942, about 40 motorized *prahu mayang* had been sold "to domestic skippers and some middle class owners", who "made a handsome profit", for reasons Bottomanne (1959) later explained:

> In West Java, where the water was not clear and fishing was possible during the entire period of daylight [in the clearer waters off East Java fishing was only possible at dawn], 20 cycles a day were often made, whereas sailing vessels only accomplished up to 6 cycles in that region. Nets, moreover, were bigger for the motor vessels.

By the outbreak of the Pacific War, however, motorization had not gone very far. During the depression the government lowered the price of salt somewhat, but because fuel prices were high and fish prices fell sharply few people had the capital or the incentive to invest in motorized vessels.

A feature of the 1920s and 1930s was the increasing scientific interest in fisheries, particularly in the Netherlands Indies. Much of the research conducted there was devoted to studying plankton, mainly because studies of the quantity of plankton in the Java Sea and elsewhere could be used as an indirect indicator of the abundance of fish stock, an issue about which there appears to have been intense debate at the time, in sharp contrast to the nineteenth century when the abundance of fish in the archipelago was an article of faith among Europeans. A.W. Herre's comments give some idea of the nature of the debate as well as his own views on it:

> There is an impression, based upon inadequate knowledge and lack of extended field experience, that Indonesian waters are poorer in fish than more northern waters. Chemical analysis of sea water, and limited collections of plankton have been held to prove that there are few fish in tropical waters. The astounding amounts of plankton that occur at times, when planktonic organisms increase to such a vast extent as to destroy most other forms of life, and the frequent recurrence of such phenomena, seem to have totally escaped the observation of those who say tropical waters are poor in fish. When one sees vast schools of sardines, as much at times as ten miles in length, shoals of mackerel... [etc.], he knows that such ideas are erroneous (Herre 1945).

At least within the Netherlands Indies the consensus among Dutch scientists appeared to have been that the seas of the archipelago were indeed rich in fish, even if they rejected the impressionistic statements of the previous century. An implication of this consensus, of course, was that there was no need for the sort of attempts being made in Europe to regulate fisheries. According to Delsman (1939), one of the leading researchers, "there is no question of exhausting the supply anywhere in the Archipelago - except perhaps at some river mouths - nor is any such exhaustion likely to occur as soon in the tropics as it might in Europe, since the high temperature in the tropical seas causes the growth and renewal of the fish supply to take place more rapidly than in colder climates." It is interesting to note, however, that one of Delsman's predecessors, van Kampen, had begun to develop an appreciation of the difficulties of regulating a multispecies fishery, pointing out that rules (such as had been tried in Malaya, where generally fisheries officers were much more concerned about the danger of overfishing) prohibiting small-meshed nets might protect the young of large species but made it impossible to catch shrimps and fully grown small fish (van Kampen 1922).

The Acceleration of Change

The Japanese occupation of the Western Archipelago from 1942 to 1945 had a devastating effect on fish production just as it did on most other economic activites. By the end of the war a great deal of equipment - ice plants as well as boats and gear - had been destroyed or badly damaged, imports of twine, nets and other materials had been cut off, marketing systems had been disrupted, and the purchasing power of consumers had been greatly diminished. In Malaya, total fish landings in 1944 and 1945 must had been well under half of what they had been in 1940; presumably, the same applied to Indonesia, particularly in Java, one of the places most affected by the occupation. Both in Malaya, to which the British returned in 1945, and in the Netherlands Indies, now proclaimed as independent Indonesia by Sukarno and Hatta but still controlled in some areas by the Dutch, there were desperate shortages of food. In these circumstances one of the greatest concerns of governments was to promote the production of fish, particularly since alternative sources of animal protein were in even shorter supply than they had been before the war. In Jakarta and particularly in Singapore, an added problem was the fact that the principal providers of fish to these markets in the pre-war period, namely, the Japanese fishers, had been removed. (In Malaya, the government rejected the suggestion that in order to overcome shortages the Japanese be allowed to resume fishing on the grounds that this would give them a foothold in the post-war fishing industry.) In the short term, governments did what they could to restore production to pre-war levels by facilitating imports of materials, repairing the infrastructure and restoring marketing arrangements. In Malaya, these efforts had immediate results. By 1948, landings had recovered to their pre-war level. Various restrictions imposed during the Emergency brought about a slight drop in production, but thanks to the boom prompted by the Korean War it soon began to rise again. In Indonesia, the revolution and the unsteady economic conditions that followed made the recovery more difficult than in Malaya, but by 1951, production appeared to have been back to the pre-war level.

In the longer term, governments hoped to increase production by encouraging mechanization. In Malaya, the number of motor boats increased from 327 in 1949 to 7,300 in 1958. According to the annual report of the fisheries department of the newly independent Federation of Malaya, "the introduction of smaller marine diesel engines capable of being installed in moderate-sized boats has resulted in larger, stronger fishing boats being built which are capable of withstanding rough seas and which can voyage far from land in search of fish" (Anon. 1958). The same report gives some idea of the immediate impact that mechanization had:

> The fishing grounds all round Malaya, with the exception of the southern part of the Malacca Straits, have been extended in the past few years as a result of mechanization of fishing craft. The extension is particularly evident on the East Coast where the area covered by local craft has been more than doubled since 1953... it is now common for the fishermen to follow the shoals of fish round the coast of Malaya, remaining away from home for lengthy periods, a practice which was virtually non-existent before the introduction of engines made the boats largely independent of the vagaries of the wind.

In some places mechanization took place with stunning rapidity. According to Firth (1975), the fishers of Perupok:

> did not adapt the less powerful and less efficient though cheaper outboard motors.... They hung back until they were convinced of the superiority of the inboard diesel-fuelled motors, to which they converted very rapidly. They were able to observe the motorized craft in areas of the south. In a remarkably short space of time, about eighteen months apparently, all the leading *juruselam* [fishing experts] of Perupok had invested in these motor boats.

In Perupok, motorization not only allowed fishers to reach more fishing grounds more quickly, but it also facilitated the adoption of a new and extremely productive form of fishing, purse seining.

The increases in production brought about by the mechanization were accentuated by other changes taking place at the same time. One was the widespread adoption of synthetic nets, which though much more expensive lasted longer, were lighter and so much more easily handled, were less visible to fish, and required little or no drying. According to the same report, "drift net catches in the Malacca Straits have doubled with the replacement of cotton by synthetic fibers resulting in increased supplies of *tenggiri* and *parang* to the west coast markets and a subsequent reduction in the retail prices of these fish." Also significant were the much greater use of ice and steady improvements in the transportation system.

In Indonesia, production doubled between 1951 and 1967, but mechanization appeared to have contributed much less to increases in production there than it did in Malaya. There was a great increase in the number of motorized boats, but a large proportion of these spent much of their time out of commission because of "shortages of spare parts, shortage of ice, and the elaborate procedures for obtaining sailing permits" (Krisnandhi 1969). Instead, the doubling of production came about mainly because of threefold increases in the number of fishers and nonmotorized "traditional" fishing craft. According to Krisnandhi (1969), the fishing industry during these years "has grown but not developed". Nevertheless, as he looked at the Indonesian fishing industry from his vantage point right at the start of the New Order, what struck him was not that production had increased so little in relation to the estimated potential but that it had expanded as much as it had:

> The industry had expanded substantially since 1951, for not only has total production risen but so also has fish consumption per head. The industry has been able to do this only by making substantial investments in fishing equipment. It has done this, moreover, from its own resources during a period when the national economy was becoming more and more unstable and the climate for economic

> enterprise was becoming progressively less favourable, and in the face of very considerable specific handicaps - poor communications, poor transport facilities, a "lack of modern processing and storage facilities, and a high cost marketing system."

"Under these circumstances," he added, "it is not surprising that investments by producers for the most part took traditional forms or that returns to capital and labour declined" (Krisnandhi 1969).

In both Indonesia and Malaya, fisheries officers believed that, at least in the long term, the only way the growing demand for fish could be met would be by industrializing fishing. Just like their predecessors earlier in the century, they turned their attention to the possibilities of trawling. In the 1950s, the Directorate General of Fisheries (DGF) of Indonesia "conducted experimental trawl fishing in the Madura Strait and the Java Sea. The trials were targeted at finfish and regarded as successful, but local fishers did not respond, among other reasons, due to the difficulty of obtaining engines and spare parts" at this time (Bailey et al. 1987). The premise behind a trawl survey conducted by the Colonial Office on behalf of the governments of Malaya in 1955-56 was that because "inshore 'subsistence' fisheries are now saturated," "producing as much fish as they [are] capable of," it was necessary to look to hitherto unexplored extraterritorial [meaning, at that time, beyond the three-mile limit] waters" to feed "the very rapidly growing population" and that these new fishing grounds could only be exploited by means of powerful long range vessels (Ommanney 1962). The report of this survey concluded that only a vessel of the size and power of the research ship, the 208 GT *Manihine*, could possibly engage in otter trawling, since only such a vessel could extract the net when as often happened, it got stuck in the mud and hauled up the sponges and other marine life with which the bottom was "heavily overgrown" (and which we now know are an integral part of the ecology of soft-bottom communities, "provid[ing] habitats for invertebrates and shelters for fish" [Pauly 1986]). It also concluded, however, that not even such a vessel could make a profit, because of the huge capital costs, high running expenses, the low prices of fish (no mention is made of shrimp in the report), and, not least, the fact that stocks of demersal fish were not particularly abundant. In May 1956, when the *Manihine* was still conducting its survey, a special committee set up to investigate the fishing industry concluded that "experiments have all demonstrated the unsuitability of western gears for use in Malayan waters" (Abdul Aziz 1956). The fisheries department still hoped to introduce industrial fishing, but by 1958 this hope appeared to have been focused on exploiting tuna in the Indian Ocean, for "the fish stocks of these waters offer the only realistic hope for the rapid increase in fish supplies to the Federation to meet the ever increasing demand of the growing population" (Anon. 1958).

Within the space of a few years, however, trawling became one of the most powerful fishing methods in the Western Archipelago. Considering the profound impact of trawling, it is surprising how little has been written about its introduction, but we can piece together an outline of how this came about. According to one account, it happened in this way:

> The development of trawling in Penang could be traced to the breakdown in the barter trade with Indonesia with the onset of confrontation between the two countries in 1963. The barter traders started looking for alternative use for their boats which were of 30-50 tons category. About this time a few fishermen who were interested in trawling went to Thailand to observe trawling operations there. They brought back two types of trawl nets, namely the otter trawl and the beam trawl. They found out that the unused barter traders' boats were suitable and could easily be converted for trawling (Lam and Pathansali 1977).

Other versions of this story differ slightly in detail. Yap (1976) said that the fishers of Pangkor learned about trawling from some Thai fishers who visited the island. Leaving aside such details, however, certain points are clear. First, the introduction of trawling had little to do with any attempts by the government to promote it. Second, the boats used as trawlers were very much smaller than those used in government-funded experiments. And, third, the adoption of trawling in Malaysian waters had a Thai connection. To understand the second and third points, we need to refer briefly to what happened in Thai fisheries at about this time.

Up to 1960, the marine fisheries of Thailand was (as far as finfish were concerned) devoted almost entirely to the capture of pelagic species, particularly *Rastrelliger* spp. The demersal fish of the Gulf of Thailand were virtually untouched by fishing. In 1958, Klaus Tiews, who had been conducting research in the Philippines, where trawling had been practiced in various forms for several decades, "recommended to the Government that it should be determined whether the sea fisheries could be expanded by introducing a trawl fishery" and, in 1961, work along this lines began with aid from the Technical Assistance Program of the Federal Republic of Germany (Tiews 1973). As soon as such a net had been developed, the fisheries department demonstrated its use to fishers on the fishers' own boats (an inducement was that the owners kept the catch) and trained them to tailor the nets themselves. Within just two or three years, several hundred boats had adopted the otter trawl designed by the German team.

It was, apparently, this trawl net that the fishers of the west coast of Malaya adopted beginning in 1965, converting to trawlers not only boats that had been used in the barter trade but also many purse seiners as well. In the following year, 1966, a number of fishers based at Bagan Si Api Api and fishing in the areas surrounding the Rokan estuary took up trawling. According to Bailey et al. (1987), "the profitable operations of Malaysia's trawler fleet provided the technical inspiration for this gear [otter trawls] to be adopted by Indonesia's fishermen operating in the Malacca Straits", but the net adopted appears to have been of a different type, as suggested by Unar's statement (1973) that "this fishery is characterized by the operation of wooden sampan-like motorized vessels of 5-20 GT employing a single Gulf-type shrimp trawl of 40 feet head-rope." In any case, as this statement indicates, the prime target of the trawl fishers in the Strait of Malacca was shrimp, the price of which was rising dramatically because of increasing demand, particularly from Japan, then entering a period of great prosperity. It was, in short, the increasing value of catches on the international market (rather than the demands of the domestic market) as well as technological changes that suddenly made trawling such a profitable investment. In Indonesia, the New Order government created conditions that encouraged investment in the fishing industry.

Conclusion

From our vantage point in the mid-1990s, we can see the period from about 1955 to 1970 as a turning point in the history of fisheries in the Western Archipelago. During these years production increased dramatically, first in Malaysia and then in Indonesia, because of rapid mechanization and a number of related changes. Where once fishers tended to own and operate their own boats and nets, more and more, those who went to sea were employees of land-based entrepreneurs, intent on maximizing the return on their investments. As the intensity of fishing increased, so too did conflict between those operating different types of gear, as did pressure on what had, only a few decades earlier, been assumed to be an inexhaustible resource. The challenges that fisheries officers and scientists face today date from this period of momentous change. Nevertheless, the rapidity with which change took place at this time can only be understood in relation to the changes that had already taken place. By the 1950s, fishing was highly commercialized; the population of the Western Archipelago had grown manyfold from what it had been in the middle of the nineteenth century, thanks in part to the nutrition provided by fish; there were signs of overfishing in certain quite localized areas, such as the inner part of the Rokan estuary and the reef slopes where the Japanese *muro ami* teams fished, just as there were signs that refuse generated by human activities on land were a threat to fishing (Maxwell [1921b] stated that the *trubuk* fishery of Malaya "appears to be on the verge of extinction" because of the pollution caused by tin mining); and fisheries scientists had made progress in mapping out the location of the remaining areas that could be exploited, even if they had little idea of the potential of demersal stocks. The revolution that occurred between 1955 and 1970 grew out of the great changes that had taken place over the preceding century - even if, from our vantage point today, they appear less spectacular.

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The Mid-1970s Demersal Resources in the Indonesian Side of the Malacca Strait[a]

Q1604; Q1603;
Demersal fisheries
Trawling / Catch/effort
Fisheries / Catch composit.
ISEW, Malacca Strait
ISEW, Indonesia

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Abstract

The results of demersal surveys in the Indonesian half of the Malacca Strait area by the research trawlers *Mutiara 1, 2* and *4* conducted in 1973 and 1975 gave an estimate of the standing stock of 73,000 t. Comparing with other areas, and considering the state of exploitation of the resources in the mid-1970s, the unexploited stock was estimated to have been around 150,000 or 2.66 t·km^{-2}. Catch rates and catch composition by depth are given.

The commercial trawl fishery in the Indonesian Malacca Strait prevailing in the 1970s was analyzed on the basis of the statistics in provincial reports and of field interviews. Sustainable yields for two distinct fisheries, Aceh and North Sumatra-Riau, were estimated to be 8,000 t·year^{-1} and 77,000 t·year^{-1}, respectively. The stocks were, at the time, beginning to be overfished.

Abstrak

Hasil survei sumberdaya demersal di Selat Malaka dengan kapal trawl Mutiara 1, 2, *dan* 4 *yang dilaksanakan pada tahun 1974 hingga 1975 memberikan estimasi kelimpahan ikan sebesar 73.000 t. Dibandingkan dengan daerah lain, dan mengingat tingkat eksploitasi pada pertengahan tahun 1970-an, stok ikan pada tingkat awal diperkirakan 150.000 t atau 2,66 t. per km^2. Hasil tangkapan rata-rata dan komposisi hasil tangkapan disajikan dalam tulisan ini.*

Keadaan perikanan trawl di Selat Malaka di sekitar tahun 1970-an dianalisis berdasarkan data statistik propinsi dan kabupaten serta wawancara di lapangan. Potensi lestari perikanan di sekitar dua daerah, Aceh dan Sumatra Utara-Riau, diperkirakan masing-masing sebesar 8.000 t. dan 77.000 t. per tahun. Saat itu sudah terlihat adanya gejala lebih tangkap.

Introduction

The Malacca Strait (Fig. 1), being one of the world's main shipping routes, is rather well documented in the geological and maritime literature (see Emery 1971; Valencia 1979 and Box 1).

The fisheries of the Malacca Strait are also well documented (SCSP 1976a, 1976b, 1978), although the small pelagics (especially mackerels and scads) have received far more attention than the demersal fishes (c.f. Sujastani 1975, 1976; Anon. 1976a, 1976c, 1976d, 1987 for pelagics; Mansor Mat Isa 1987; Sivasubramaniam 1987; Tampubolon and Sedana Merta 1987; Tampubolon 1988; Soriano et al. 1988 *vs* Menasveta 1970; Anon. 1976b, 1976e; and Mahyam Binti Mohd. Isa 1988.

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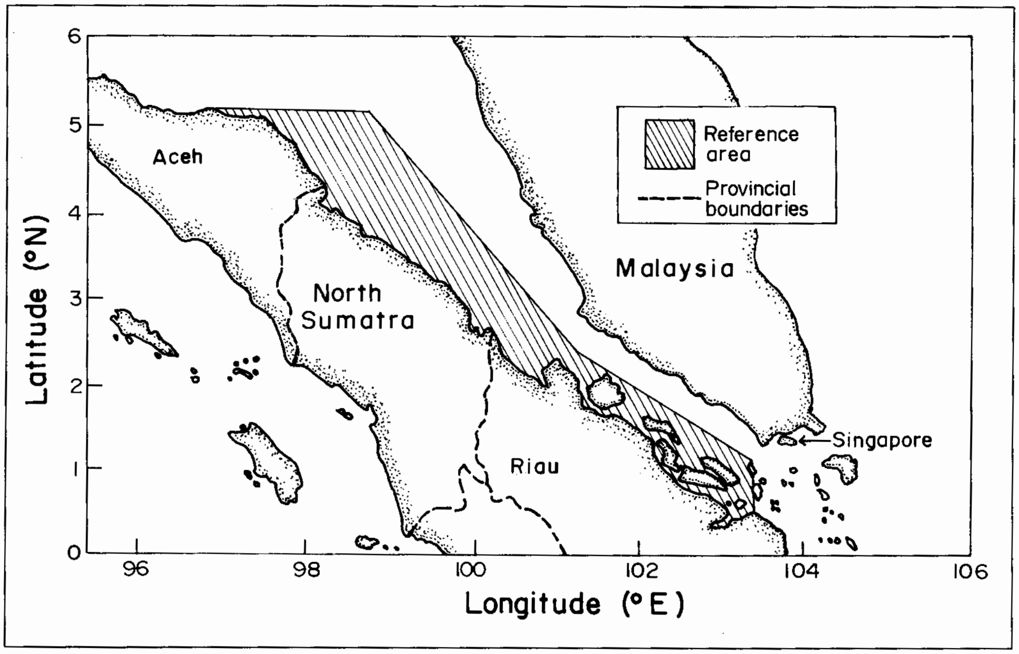

Fig. 1. The Indonesian part of the Malacca Strait (shaded), covering an area of about 55,000 km^2.
[Gambar 1. Selat Malaka bagian Indonesia (diarsir), meliputi luas sekitar 55.000 km^2.]

Table 1. Specifications of the research vessels and gear used for trawl surveys on the Indonesian side of the Malacca Strait, 1973 and 1975.
[Tabel 1. Spesifikasi kapal dan alat yang digunakan dalam survei di Selat Malaka, 1973-1975.]

Name of boat	Gross tonnage	h.p.	Length (m)	Gear	Length of head rope (m)	Mesh size of codend (mm)
Mutiara 1	124	365	23.6	double rig[a]	23.4 (each)	30
Mutiara 2	53.4	165	18.9	double rig[a]	19.0 (each)	30
Mutiara 4	110	316	24.0	Thailand trawl	36.0	40

[a]Shrimp trawl.

Menasveta (1970) reviewed the bottom trawl surveys conducted in the Malacca Strait, notably the results of trawling by the *R/V Tongkol* (Birtwistle 1928), the *R/V Manihine* (Ommanney 1961), and the *Selayang* (Pathansali et al. 1966). Later surveys were conducted with *K.M. Jenahak* (Latiff 1973). Most of these surveys were conducted in what are now Malaysian territorial waters; less information is available on the Indonesian side of the Malacca Strait.

A first report on catch/effort and catch composition data obtained by two Indonesian fisheries research vessels, *R/V Mutiara 1* and *R/V Mutiara 2*, on the Indonesian stocks of the Malacca Strait, was published in Indonesian by Martosubroto (1973). The station grid of *R/V Mutiara 1* and *2* was not truly random, i.e., fishing was directed. Nevertheless, their catch rates are incorporated in the present paper, itself an updated version of Sujastani et al. (1976).

Anon. (1976e) reported on the composition of 12 trawl hauls taken on the Indonesian side of the Malacca Strait in January 1975 by *R/V Lemuru* (see Venema, this vol., for details on *R/V Lemuru*).

Further data for the present contribution originate from the survey conducted by *R/V Mutiara 4* in the Malacca Strait, in early 1975 (see Pauly et al., this vol. for the context of this survey and the sampling methods used, and Torres et al. (this vol.) for a description of a database with details on these and *R/V Lemuru*'s stations).

The fourth source of material used here is the landing and effort statistics of the Provincial Fisheries Offices of the Provinces of Aceh, North Sumatra and Riau. Additionally, interviews with skippers of commercial trawlers operating in the area were conducted towards the end of 1975 by the second author. Fig. 1 shows the area covered here.

Materials and Methods

Trawl Survey Data

The specifications of *R/V Mutiara 1, 2,* and *4* and the gears used for their surveys are summarized in Table 1.

The survey by *Mutiara 1* and *2* in the Malacca Strait lasted from July to September 1973. A total of 148 hauls were made, 61 by *Mutiara 1* and 87 by *Mutiara 2*. The survey of *Mutiara 4* lasted from 27 January to 14 March 1975 and yielded 40 valid hauls (Fig. 2, Table 2). The surface area of each depth horizon is also given in Table 2. These data were used to estimate standing stock size using the swept area method as described in Pauly et al. (this vol.) and using the same assumptions as to the catchability of the gear. Particularly, the same escapement factor was assumed to apply to *Mutiara 1, 2* and *4*.

Box. 1. Sediments and benthos of the Malacca Strait.
[Boks 1. Sedimen dan benthos di Selat Malaka.]

Emery (1971), based on Keller and Richards (1967) and other sources, describes the sediments of the Malacca Strait as consisting mainly of "*sand* (detrital or calcareous grains 0.05 to 2 mm in diameter and having a hard smooth to rippled surface), *sand-and-mud* (fine sand and silt having a firm to soft smooth surface), *mud* (silt and clay having a soft surface), *gravel* (pebbles and cobbles of broken rock, locally containing many calcareous shells), *rock* (outcrops of bedrock and boulders near outcrops), and *coral* (large areas or reefs of massive calcareous algae and coral)".

The benthos of the Malacca Strait appears to be sparse, at least offshore, far from the mouth of rivers. Neiman (1973) reports of three benthos stations (see Fig. 2 for their locations) from west to east which yielded densities of 4.4 g^{-2} (shallow water) 1.0 g^{-2} in (deep water) and 2.4 g^{-2} (shallow water). He also mentions that far from the mouths of rivers, otter trawls often catch sponges and soft corals, and sea urchins.

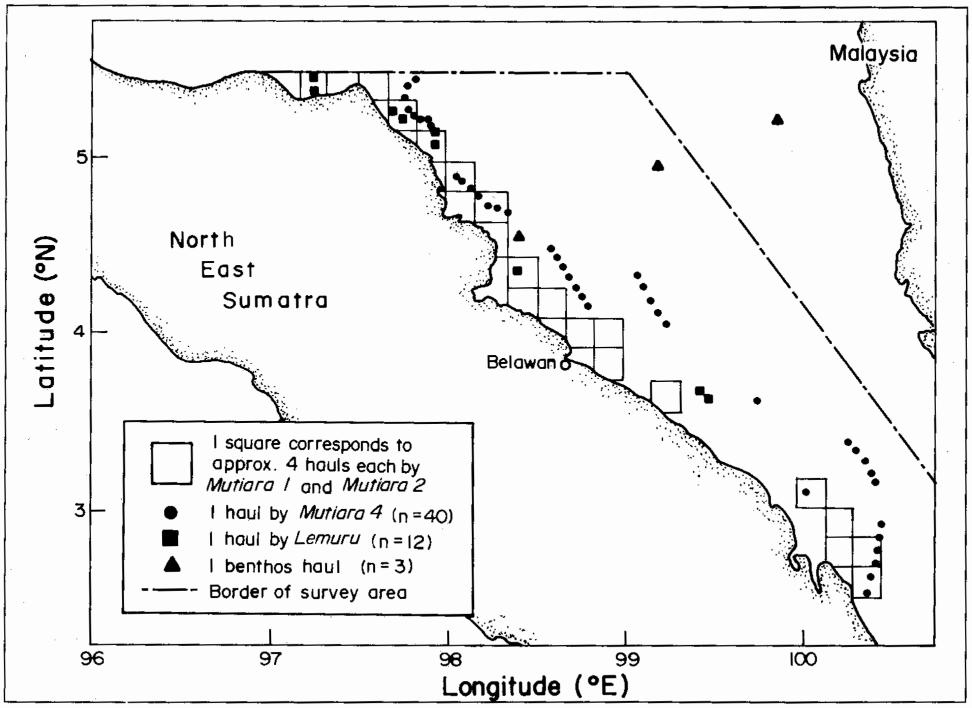

Fig. 2. Location in the Malacca Strait of trawl hauls performed by *FRV Mutiara 1* and *2* in 1973, by *FRV Mutiara 4* in January/February 1975, by *FRV Lemuru* in January 1975. [Also included are three benthos grab hauls made by *R/V Akademik Knipovich* in 1966]. *[Gambar 2. Lokasi stasiun trawl di Selat Malaka oleh kapal penelitian Mutiara 1 dan 2 pada tahun 1973, kapal Mutiara 4 pada Januari/Februari 1975, kapal Lemuru pada Januari 1975. (Termasuk juga tiga stasiun pengambilan contoh benthos oleh kapal penelitian Akademik Knipovich pada tahun 1966).]*

Table 2. Haul numbers of *Mutiara 1, 2* and *4* in the Malacca Strait, 1973 and 1975.
[Tabel 2. Jumlah hauls/tarikan Mutiara 1, 2, *dan* 4 *di Selat Malaka, 1973-1975.]*

Depth (m)	Surface area (km^2)	No. of hauls by Mutiara: 1	2	4
0-9	7,354	2	5	-
10-19	6,860	31	44	-
20-29	4,710	16	38	1
30-39	5,378	12	-	7
40-49	4,719	-	-	11
50-59	7,792	-	-	14
60-69	8,561	-	-	4
70+	10,097	-	-	3
Total	54,931	61	87	40

Box 2. Standardization of trawling effort.
[Boks 2. Pembakuan upaya penangkapan trawl.]

Standardizing the effort of trawlers can be done by relating their catch per effort to their tonnage (as index of "power", since large boats require large engines). The table below documents how the large, medium, and small trawlers were standardized such as to obtain a measure of fishing effort (days fished per year) comparable between provinces.

Vessel characteristic	Large trawlers	Medium trawlers	Small trawlers
Boat class (GT)	> 20	10-20	10
Mean gross tonnage	30	20	10
Average catch (kg·day^{-1})	276	218	160[a]
Power factor	1.27	1	0.74
Nominal effort[b] (by province)			
Aceh	264	-	-
North Sumatra	288	264	240
Riau	280	-	-
Effective effort[c] (by province)			
Aceh	335	(264)	-
North Sumatra	336	264	178
Riau	356	(280)	-

[a]As obtained by linear extrapolation, down to 10 GT, of ratio of catch:tonnage.
[b]Trawler days at sea.
[c]Days at sea of a standard trawler.

The *FRV Lemuru* data were not used for standing stock estimates owing to the small number of hauls (Fig. 2).

Commercial Catch Data

The fisheries catch data originate from the Provincial Fisheries Offices of the Provinces of Aceh, North Sumatra, and Riau and go back as far as reports were available (to 1969). The second author also conducted field interviews in the three abovementioned provinces from November to December 1975. In Aceh Province, four large landing places were visited with about three interviews of trawler skippers at each landing site. In North Sumatra Province, landing sites were visited with the same rate of interviews. In Riau Province, only three landing places were visited with four interviews each. Catch per unit of effort data and effort data (actual fishing days) for large and medium trawlers in the three provinces were derived from these interviews.

The provincial reports did not assign the landed fish and shellfish to the gear that caught them. It was thus necessary to identify, from the catch data, those groups of fish and shellfish which could be assumed to originate from trawl catches. This was done on the basis of Table 3 by assuming that fish contributing more than 2% to the survey catches of *Mutiara 1, 2* or *4* were mainly demersal. Those fishes were then selected from the reports' lists and their catches combined to represent the trawler's catches.

When presenting the data, care was taken to avoid double accounting, as occurred between the Province of North Sumatra, where many trawlers from Riau landed their catch, and the latter province. As no figure was available on the amount of this double accounting, a figure of 50% was assumed; accordingly, the catches reported from Riau Province were cut by half.

Annual catch was plotted against the corresponding levels of effort for the Malacca Strait as a whole and for Aceh Province and North Sumatra-Riau Provinces.

Table 3. Demersal fish catch composition (% of weight) in the Malacca Strait by research vessel and depth range.
[Tabel 3. Komposisi hasil tangkapan sumber daya demersal (berat dalam %) di Selat Malaka berdasarkan kapal dan kedalaman.]

Depth range (m)	0-9		10-19		20-29			30-39		40-49	50-59	60-69	70+
Group or species/*Mutiara*	*1*	*2*	*1*	*2*	*1*	*2*	*4*	*1*	*4*	*4*	*4*	*4*	*4*
Sharks and rays	0.2	0.4	0.7	1.7	3.1	0.3	3.3	1.1	0.5	15.7	1.4	1.0	0.9
Engraulidae	0.2	0.1	1.4	2.6	1.4	1.4	-	0.8	1.7	1.2	0.1	8.0	-
Clupeidae	1.7	4.9	1.1	4.1	0.8	2.5	41.9	0.1	3.9	4.1	3.9	12.8	0.7
Chirocentrus dorab	0.6	1.0	4.1	1.6	2.9	1.6	-	1.8	0.1	0.4	0.1	0.1	0.8
Anadontostoma chacunda	-	-	0.3	0.1	0.1	-	-	0.1	-	-	-	-	-
Synodontidae	0.4	1.5	2.3	5.3	1.8	3.9	-	9.8	2.0	0.5	2.6	2.4	2.8
Ariidae	-	0.7	0.9	0.4	2.6	0.5	-	2.9	0.7	4.3	1.8	7.0	0.2
Sphyraena spp.	0.3	0.3	0.6	0.5	1.2	0.6	-	0.7	6.9	1.5	0.2	-	-
Serranidae	-	0.1	0.5	0.7	1.5	0.1	-	1.9	0.4	0.1	2.1	-	0.6
Terapontidae	0.9	6.4	2.2	3.8	10.4	1.9	0.9	9.0	0.9	0.3	1.1	2.6	0.3
Priacanthidae	-	-	0.1	0.1	1.4	0.1	-	0.9	0.5	1.3	2.0	0.3	0.3
Rachycentron canadus	-	-	0.1	0.5	-	-	-	-	-	0.4	0.1	-	-
Carangidae[a]	1.9	8.3	4.3	6.6	3.5	4.6	4.4	3.2	16.5	11.5	6.2	7.3	15.5
Formio niger	-	0.2	0.3	0.3	0.4	0.1	-	0.1	0.5	0.2	0.1	0.1	0.9
Lutjanidae (incl. *Caesio* spp.)	-	-	1.0	0.5	0.9	0.8	-	2.4	1.3	5.4	14.4	8.4	.9
Nemipteridae[b]	-	-	2.1	2.8	1.8	3.5	-	2.8	7.5	5.6	6.4	6.8	3.5
Leiognathidae	0.5	7.5	26.8	5.1	20.7	12.6	17.7	8.8	2.9	8.4	7.8	0.3	0.3
Gerreidae	0.9	1.6	1.3	0.6	0.8	0.6	-	1.1	-	2.4	9.5	0.6	17.6
Pomadasyidae[c]	10.9	6.9	5.8	1.7	5.9	1.6	-	4.6	3.9	7.5	4.3	19.4	4.9
Sciaenidae	15.7	11.2	4.4	10.0	3.8	8.8	0.9	4.5	-	4.2	0.9	7.7	-
Mullidae	-	0.9	3.3	2.4	4.5	5.1	-	8.9	6.4	10.7	10.0	1.3	22.9
Siganus spp.	3.4	-	3.9	-	1.9	-	-	1.0	2.1	1.1	0.1	-	0.1
Trichiuridae	1.4	0.9	4.0	5.4	2.5	3.0	8.8	6.1	2.2	3.3	8.8	6.5	1.4
Rastrelliger spp.	1.4	-	0.2	0.6	0.1	-	-	-	-	0.2	1.3	-	-
Scomberomorus spp.	0.3	0.8	0.9	0.4	1.0	0.7	-	1.3	-	-	-	-	-
Pampus argenteus	-	3.1	0.5	0.9	0.2	0.8	9.9	0.1	2.0	0.2	-	0.2	-
Platycephalidae	0.5	2.3	0.5	0.4	1.5	-	-	2.7	0.1	0.1	0.1	-	-
Psettodes erumei	-	0.3	2.1	0.9	0.8	0.8	-	1.3	0.3	0.1	0.9	0.6	0.3
Other flatfishes	13.2	8.9	1.7	4.1	2.5	1.9	0.4	1.9	-	0.1	0.1	0.2	-
Other fishes	45.4	21.9	19.7	26.3	17.3	28.9	4.4	18.4	24.5	7.4	6.5	4.1	3.7
Loligoidae	-	1.3	-	1.8	1.3	2.5	0.4	0.3	10.1	3.6	5.3	2.1	3.7
Sepiolidae	-	1.3	0.9	2.2	1.3	0.9	-	0.1	0.8	0.5	0.8	0.3	0.2
Penaeidae	1.0	1.0	0.2	5.0	0.4	7.8	4.0	0.2	0.1	0.1	-	0.6	-
Thenus orientalis	-	-	0.3	0.1	0.7	-	-	1.1	0.1	0.1	0.2	0.1	-
Other crustaceans	-	1.7	1.0	1.0	0.3	0.6	2.6	-	0.1	0.1	-	0.1	-

[a]Excluding *Decapterus* spp.
[b]Including *Scolopsis* spp.
[c]Including *Plectorhynchus* spp.

Commercial Effort Data

The official reports on the number of boats did not state whether these were trawlers or seiners. It was assumed that the large, medium and small motorized boats were trawlers, and that none of the sailing boats were engaged in trawling. The small motorized boats in Riau Province were mainly gillnetters, and were thus not included; neither were some unregistered motorized boats in North Sumatra operating as purse seiners.

On the basis of the field data, it appears that the large trawlers had an average gross tonnage of 30 t, the medium trawlers of 20 t, and the small trawlers of 10 t (Box 2). The medium-sized trawlers were selected as standard, and the other types converted to this by means of their catch per unit effort (Box 2).

Nominal fishing days for each type of trawler in each province were then multiplied by the appropriate power factor, which led to a measure of effective effort ("corrected fishing days").

Combined with the abovementioned catch data, these estimates of effort allowed the parametrization, via plots of catch/effort *vs* effort, of surplus production models, subject to the caveats in Martosubroto (this vol.).

Results and Discussion

The area covered the surveys of *Mutiara 1* and *2*, and the trawl haul stations of *Mutiara 4* and *Lemuru* are shown in Fig. 2. The composition of the catch of *Mutiara 1* and *2* is given in Table 3 together with that of *Mutiara 4*. To facilitate comparison, all figures were converted into percentages of total catch. For the same reason, those groups of fishes recorded on only one or two of the boats have been added to "other fishes".

Table 4. Mean fish stock densities by depth in the Indonesian sector of the Malacca Strait.
[Tabel 4. Rata-rata densitas stok ikan pada berbagai daerah di paparan Sunda.]

Depth (m)	Mean catch/effort ($kg \cdot hour^{-1}$) of *Mutiara*			Biomass ($t \cdot km^{-2}$) based on *Mutiara*:			
	1	*2*	4[a]	*1*	*2*	4[a]	Mean
0-9	36.7	65.3	-	0.5	1.4	-	0.9
10-19	77.8	45.4	-	1.1	1.0	-	1.0
20-29	77.7	41.0	45.3	1.1	0.9	0.7	0.9
30-39	68.4	-	63.9	1.0	-	1.0	1.0
40-49	-	-	158.2	-	-	2.5	2.5
50-59	-	-	100.1	-	-	1.6	1.6
60-69	-	-	84.1	-	-	1.3	1.3
70+	-	-	94.4	-	-	1.5	1.5

[a]Mean values for the surveys documented in Pauly et al. (this vol.).

A feature discussed by Menasveta (1970), the increase with depth of the percentage of more valuable fish groups was confirmed for the Lutjanidae, Serranidae, Carangidae, Pomadasyidae, and others. Less valuable groups such as the Leiognathidae, Siganidae, Sciaenidae, Platycephalidae, and "other fishes" decreased with increasing depth.

Table 4 summarizes the estimates of standing stock, by depth range. Overall, a standing stock of about 80,000 t was estimated for the Indonesian waters of the Malacca Strait, as delimited in Fig. 1., but excluding the depth range 0-9 m, i.e., for a reference area of 47,600 km^2. This corresponds to a mean stock density of 1.67 $t \cdot km^{-2}$. Here, however, the value for the depth range 10-19 m, where the *Mutiara 4* had not been fishing, was assumed to correspond to the relatively high average value of the same depth range from other, mostly unexploited areas covered by *Mutiara 4* (see Pauly et al., this vol.).

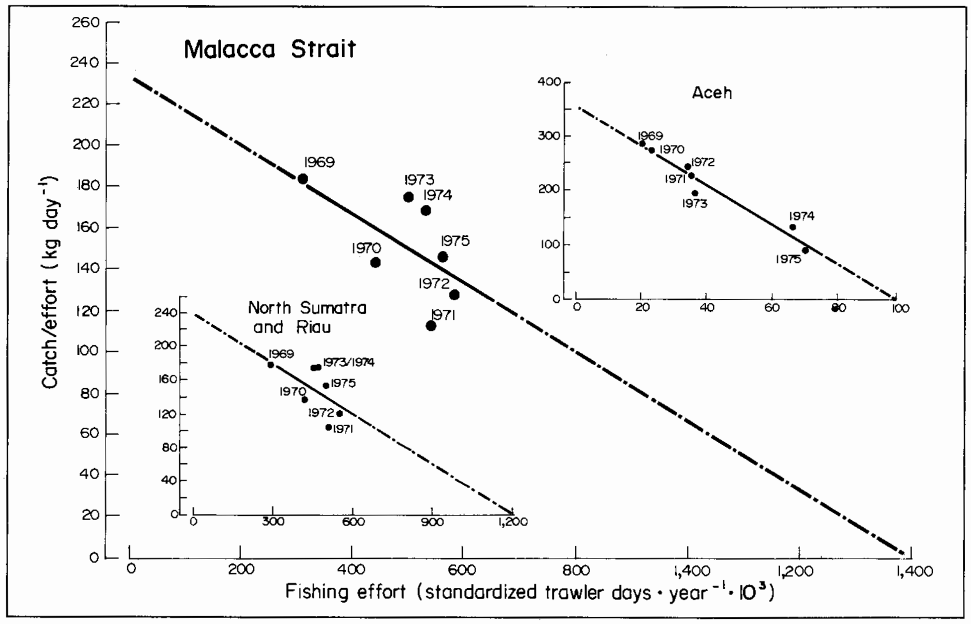

Fig. 3. Trawler catch/effort *vs* effort on the Indonesian side of the Malacca Strait, 1969-1975; note decline, for both subareas considered here (Aceh and North Sumatra-Riau), and consequently, for the area as a whole (see also Table 5).
[Gambar 3. Hubungan antara hasil tangkapan per upaya penangkapan dan upaya penangkapan di Selat Malaka bagian Indonesia, 1969-1975; perhatikan grafik penurunan untuk kedua daerah (Aceh dan Sumatra Utara-Riau) dan selanjutnya untuk seluruh daerah (lihat juga Tabel 5).]

In the specific case of the Malacca Strait, this assumption was probably too optimistic, as heavy trawling was already taking place in the shallow waters. Thus, to correct this figure, the stock densities obtained from the catch rates of *Mutiara 1* and *2* were also calculated (Table 4). These estimates were then used for the depth ranges missing in the *Mutiara 4* survey, while overlapping data of the three boats were averaged. The results are also presented in Table 4, from which an average weighted mean stock density of 1.33 $t \cdot km^{-2}$ was derived (including the depth range 0-9 m). The corrected stock estimate, thus, amounts to 73,000 t, over a surface area of 55,000 km^2.

The value of 1.33 $t \cdot km^{-2}$ and the corresponding standing stock are very low when compared with the data from other areas of the Sunda Shelf (see Pauly et al., this vol.), where the average stock density was 2.66 $t \cdot km^{-2}$, exactly double the Malacca Strait figure. The low density in the Malacca Strait is most probably the result of the existing trawl fishery, which is backed by the fact that it is mainly the shallow waters (down to 39 m) of the Malacca Strait (where almost all, if not all of the trawling takes place) that the stock densities differ from those of other areas. It seems, therefore legitimate to assume, as a first approach, that the unexploited standing stock, before the onset of the trawl fishery, was also double the stock observed in the mid-1970s, or about 150,000 t.

Based on the plots of catch/effort *vs* effort (Fig. 3), maximum sustainable yield (MSY) was estimated at about 8,000 $t \cdot year^{-1}$ for Aceh Province, and 77,000 $t \cdot year^{-1}$ for North Sumatra and Riau combined. Overall, an MSY yield of 85,000 $t \cdot year^{-1}$ was estimated for the Indonesian waters of the Malacca Strait (Fig. 4).

The above figure of 85,000 $t \cdot year^{-1}$ is compatible with an unexploited stock estimate (B_0) of 150,000 t (see above), i.e., implying that MSY $\approx M \cdot \frac{1}{2} B_0$ (Gulland 1971), with M set at 1

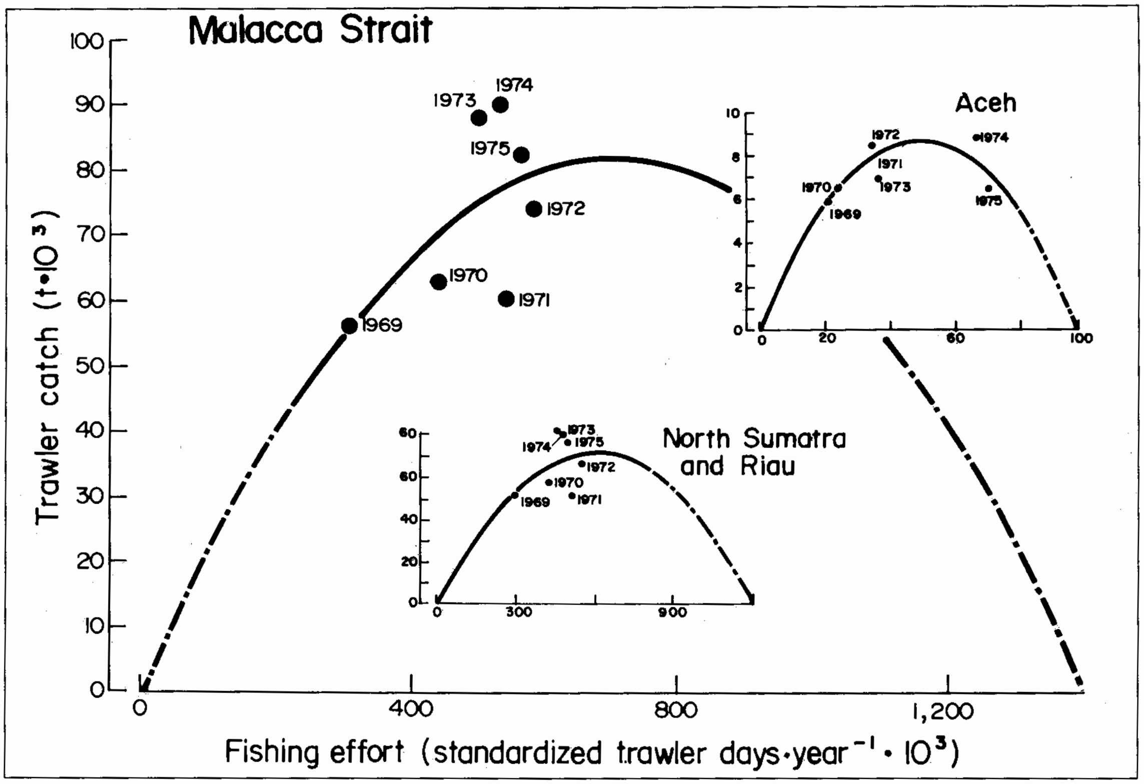

Fig. 4. Trawler catch *vs* effort on the Indonesian side of the Malacca Strait, 1969-1975. Note that effort was near optimal in the mid-1970s for the area as a whole, and for North Sumatra-Riau, but not for Aceh province, where effort was then already excessive.

[Gambar 4. Hubungan antara hasil tangkapan dan upaya penangkapan di Selat Malaka bagian Indonesia, 1969-1975. Perhatikan upaya yang mendekati optimal pada pertengahan tahun 1970an untuk seluruh daerah, dan juga untuk Sumatra Utara-Riau, tetapi tidak untuk propinsi Aceh, karena upaya penangkapan sudah melebihi optimal.]

year^{-1}, a value commonly used for the multispecies demersal stocks of Southeast Asia (see Pauly, this vol.). Further, the standing stock estimate of 73,000 t ≈ ½ B_0, as should occur when fishing effort is at the level generating MSY (Gulland 1971; Ricker 1975; Pauly 1984). Thus, it can be concluded that, overall, the level of trawling effort applied in the mid-1970s to the demersal stocks of the Indonesian side of the Malacca Strait was about right - except in very shallow waters, where the small shrimps attracted an excessive amount of effort. Sujastani et al. (1976), based on these findings, presented a set of practical recommendations for managing the fisheries. [These recommendations, not recalled here, became irrelevant when trawling was banned in Western Indonesia (Sardjono 1980, and see Martosubroto, this vol.); a move which also placed constraints on field sampling with trawls by MFRI scientists, due to strong objections by small-scale fishers].

Rather, we point at the compatibility of the results presented here, which as in the case of the Java Sea (Martosubroto, this vol.) integrate fisheries and survey data into a coherent whole.

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The *Mutiara 4* Surveys in the Java and Southern South China Seas, November 1974 to July 1976[a]

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Abstract

This account, which consolidates data from two earlier reports, presents the methodology and major results of a series of Indonesian-German trawl survey cruises conducted in the mid-1970s with *FRV Mutiara 4* in the Java Sea, and the southernmost tip of the South China Sea, to serve as background for detailed analyses of the demersal communities thus sampled.

Abstrak

Makalah ini, yang menggabungkan data dari dua laporan terdahulu, mempresentasikan metode dan hasil utama beberapa kali survei trawl Indonesia-Jerman dalam pertengahan tahun 1970-an dengan kapal penelitian Mutiara 4 *di perairan Laut Jawa dan bagian selatan Laut Cina Selatan, sebagai dasar analisis rinci komunitas sumberdaya ikan demersal.*

Introduction

The Indonesian-German Demersal Fisheries Project reported upon here was one of the outcomes of the *Seminar on the Possibilities and Problems of Fisheries Development in Southeast Asia*, which took place in 1968, in Berlin, under the sponsorship of the German Foundation for Developing Countries and FAO (Tiews 1969). In 1972, the Indonesian Government and that of the Federal Republic of Germany agreed to cooperate in carrying out a survey of the bottom fishes in the Java Sea and adjacent areas, to provide the basis for a development of the trawl fisheries similar to the one that had occurred earlier in the Gulf of Thailand.

This account covers the first operational phase of the project, from late 1984 to mid-1986 (see below for details on the second phase), and is based on Saeger et al. (1976) and Martosubroto and Pauly (1976).

Materials and Methods

Institutional Arrangements and Personnel

The executing agencies were, on the Indonesian side, the Directorate General of Fisheries (DGF), with Mr. V. Susanto as counterpart Project Manager. On the German side, the executing agencies were "GAWI" and "BFE", both predecessors

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of the German Agency for Technical Cooperation (GTZ), which fielded Dr. J. Saeger as Project Manager.

The project started with the construction of a trawler, the *Mutiara 4* (Box 1, Fig. 1).

The Marine Fisheries Research Institute (MFRI) in Jakarta, where the project was based, provided as biologists Messrs. Purwito Martosubroto, Johannes Widodo, Badrudin, Ir. Achmad Sudradjat, Achmad Basyori, Ir. Isom Hadisubroto, and Toman Panggabean. Mr. Wasilun and Mr. Widji Santosa also participated in the activities of the project.

The counterpart scientists functioned under the general supervision of the late Mr. M. Unar (MFRI Director), Daniel Pauly was assigned by GTZ to the project from May 1975 to December 1976. Captain P. Jarchau replaced Captain W. Spiering during his home leaves in 1974 and 1975, and permanently from 1976 on.

Box 1. The *Mutiara 4.*
[Boks 1. Mutiara 4.]

The *Mutiara 4* ("Pearl" in Indonesian) is a wooden stern trawler. She is equipped with a 316-hp main engine (nominal rating), auxillary engines and echosounders. The fishing winch allows trawling at depths down to 100 m. The cooled fish hold has a capacity of 12 tonnes. A two-drum oceanographic winch allows studies of water properties as well as benthos and plankton sampling. The principal dimensions of *FRV Mutiara 4* are:

Length overall	24.15 m
Length designed WL (=DWL)	23.00 m
Length between perpendicular	21.00 m
Breadth moulded	5.80 m
Breadth overall	5.92 m
Depth moulded a midship	2.87 m
Draft moulded (DWL)	2.23 m
Draft max. aft (DWL)	3.02 m
Drag of keel	1.00 m
Tonnage of keel	111 GRT[a]
Fish hold capacity	45 m^3 approx.
Fuel oil capacity	12.2 t in two tanks
Freshwater capacity	8.92 t
Crew	13 persons (1 captain, 4 officers, and 8 other crew)
Main engine output (t) (tropical conditions)	286 hp at 1,650 Rpm (Deutz B/ 12M716)

The trawler was built at the IPPA Shipyard in Semarang, Central Java, under the supervision of GTZ which provided the abovementioned equipment while the DGF funded the construction of the hull.

[a] 1 GRT = 100 cubic feet = 2.83 m^3.

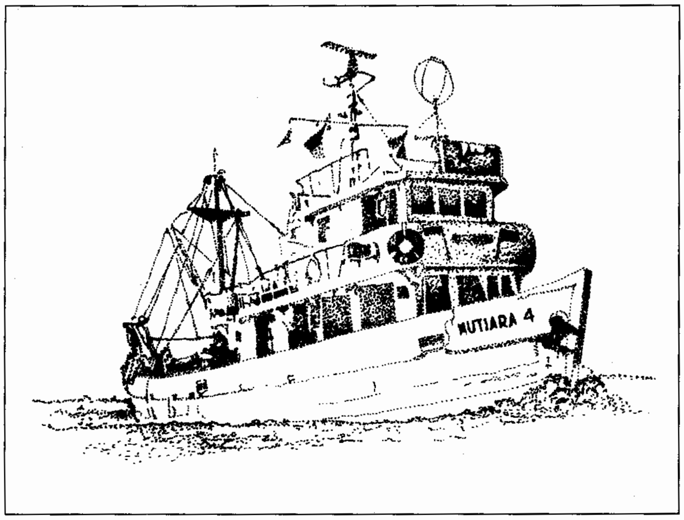

Fig. 1. The fisheries research trawler *Mutiara 4* (see also Box 1).
[Gambar 1. Kapal penelitian trawl Mutiara 4 *(lihat juga Box 1).]*

The Survey Area

The survey area covered much of the Sunda Shelf, about 772,500 km^2, or 238,400 nm^2, and was divided in six areas as shown on Fig. 2. Area 6, the Malacca Strait, is not reported upon here (but see Martosubroto et al., this vol.).

The distribution of the various depth ranges in the six areas was estimated by drawing isobaths on maps as large as possible, cutting out the figures thus obtained and weighing the paper pieces. The percentage weight of the various depth horizons was then related to the total area. Mangrove and other areas of intertidal vegetation and coralline areas were all included in the 0-9 m depth range. Areas deeper than 70 m were all put in the "70+" category. These results are shown in Table 1 and were used for all subsequent analyses. To avoid the fixed gears of small-scale fishers, no trawling occurred at depths of 0-9 m;

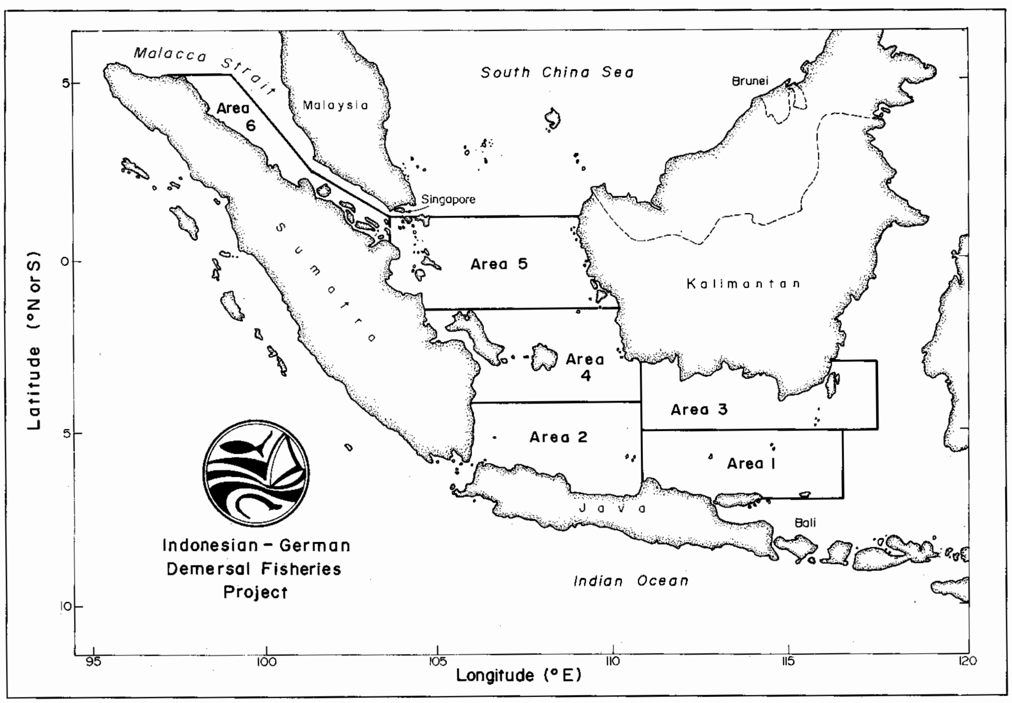

Fig. 2. The area surveyed by *Mutiara 4* from November 1974 to July 1976 (excluding the Malacca Strait, treated by Martosubroto et al., this vol.).
[Gambar 2. Daerah survei Mutiara 4 *dari November 1974 hingga Juli 1976 (tidak termasuk Selat Malaka yang dibahas dalam Martosubroto et al., pada volume ini).]*

Table 1. Surface of the Sunda Shelf in km^2 surveyed by *Mutiara 4* from November 1974 to July 1976[a].
[Tabel 1. Luas paparan Sunda dalam km^2 yang disurvei oleh Mutiara 4 *dari November 1974 hingga Juli 1976*[a]*.]*

Depth (m)	Area 1	Area 2	Area 3	Area 4	Area 5	Total
0-9	3,740	6,787	14,161	24,403	10,341	59,432
10-19	2,063	8,118	17,838	28,880	22,960	79,859
20-29	5,932	23,688	24,782	28,880	35,054	118,336
30-39	6,706	14,239	27,097	55,016	54,333	157,391
40-49	13,025	50,836	27,914	7,220	36,105	135,100
50-59	16,378	24,886	15,523	-	13,671	70,458
60-69	42,042	3,593	5,447	-	2,103	53,185
70+	39,076	931	3,268	-	526	43,801
Total	128,962	133,078	136,030	144,399	175,093	717,562

[a]Excluding Area 6 (Malacca Strait, treated in Martosubroto et al., this vol).

Box 2. Mesh selection experiments.
[Boks 2. Percobaan seleksi mata jaring.]

A selection experiment was conducted on 18 November 1975 close to the harbor of Semarang at depths ranging from 20 to 30 m. For this, the codend of the trawl, with a mesh size of 40 cm (stretched mesh), was covered with a codend of 12 cm (stretched mesh). The results were as follows:

Genus/Species	Number in codend Inner	Outer	Mean selection length (TL, cm)[a]
Rastrelliger kanagurta	318	327	10
Arothron leopardus	119	38	6[b)]
Upeneus spp.	300	806	10.2
Gerres spp.			
Pentaprion longimanus	62	123	8.8
Dussumieria hasselti	136	102	9.5
Saurida undosquamis	63	445	13[b)]
Apogon ceramensis	47	106	8

[a]Mean length at first capture, i.e., L_c or L_{50}.

[b]Rough estimates.

Aoyama (1973) published mean selection lengths for 15 species for codend of different mesh sizes. His values and ours can be compared only for *Apogon*, the only fish covered both by his and our experiments. Here, the results correspond nicely, as he gives 8.2 cm mean retention length for a mesh size of 3.8 cm, while we found 8 cm for a mesh size of 4.0 cm.

consequently, this depth range was excluded from all standing stock estimates, as were the stations used for selection experiments (Box 2) for inferences of fish behavior (see Box 5 below), or for obtaining live fish for tagging and aquarium experiments, not reported here.

Trawl Sampling and the Swept Area Method

Throughout the whole survey, a trawl has been used which was similar to the one developed in Thailand at the onset of this country's expanding trawl fisheries expansion, and commonly known as the "Thailand trawl" (Fig. 3). This was slightly modified in June 1976 (see Martosubroto, this vol.) presumably without marked impact on catch rates.

All fishing took place between 0500 and 1900 hours, the stations generally following each other on a "station line" of 4-7 hauls (our few oceanographic stations were placed at th

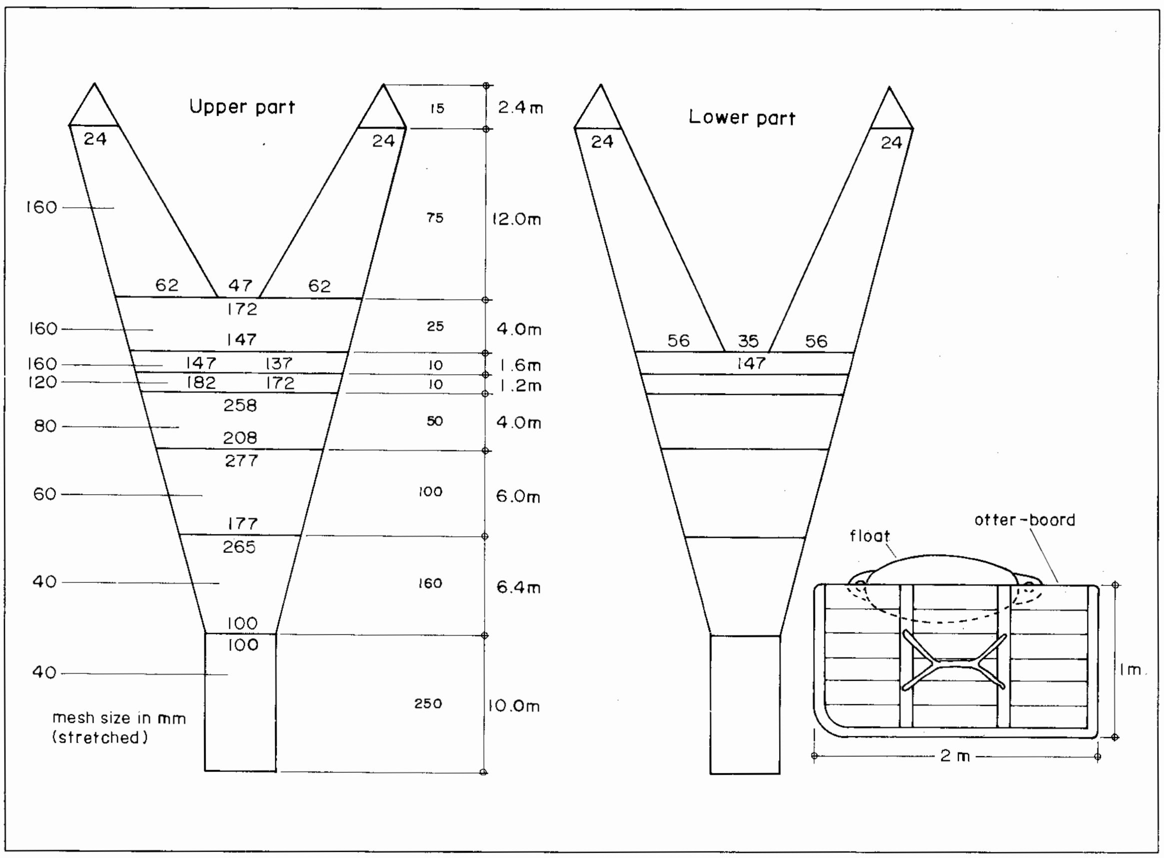

Fig. 3. The "Thailand trawl" and the otter boards used by *Mutiara 4*.
[Gambar 3. Diagram "Thailand trawl" dan otter board yang dipakai Mutiara 4.]

Box 3. Species identification and sorting.
[Boks 3. Identifikasi dan sortasi jenis ikan.]

The practice of sorting scientific trawl catches to the family level only was inherited from the previous Thai-German Trawl Fisheries Development Project (see e.g., Ritragsa 1976) which served as model for the project reported upon here. Actually, sorting to species would have been possible - even for what at first appeared a bewildering number of species - given adequate (self)training of all participating biologists.

Available identification tools for shipborne identification included the book of Munro (1967), the FAO identification sheets of Fischer and Whitehead (1974) and an array of family-specific keys, e.g., that of Kühlmorgen-Hille (1968) for the Leiognathidae.

In the second phase of this project, from about mid-1976 on, sorting was done to species level, which greatly increased the value of the survey results for stock assessment and biodiversity studies (see also Pauly, this vol. and Bianchi et al., this vol.).

Box 4. Observations on zooplankton.
[Boks 4. Pengamatan zooplankton.]

Some zooplankton sampling was done in Area 5, first through vertical tows of a Hansen (fish) larval net; this was not effective, so new collectors were built which could be towed obliquely. Our zooplankton biomass estimates were as follows:

Station[a]	38	44	50	56	62	68	75	82	88	94	100	104
Depth (m)[b]	30	40	38	26	22	16	30	20	32	46	20	20
Water filtered (m^3)[c]	179	327	251	187	200	90	46	60	103	72	64	50
Zooplankton biomass ($g \cdot m^{-3}$)[d]	0.27	0.14	0.10	0.10	0.08	0.15	0.17	0.15	0.06	0.05	0.13	0.08

[a]Area 5 only; see Fig. 4 for locations.
[b]Lowest depth of oblique tow, as estimated from simultaneous BT records.
[c]Based on a calibration experiment conducted in Tanjung Pinang Harbour.
[d]Wet weight.

These data match closely previous biomass estimates (Anon. 1973) which give values of 0.1 $g \cdot m^{-3}$ for the Java Sea. We also noted large concentrations of jellyfish, when surveying Area 4.

Box 5. Observation on zoobenthos.
[Boks 5. Pengamatan zoobenthos.]

Some benthos samples were taken in Areas 4 and 5 with a van Veen grab whose open jaws covered a surface area of 0.1 m^2. Generally, 50 % of each bottom sample was kept and preserved in 4% formaldehyde in seawater, and later sorted after sieving over 500 micron meshes. Mollusc shells, found to be regularly empty, were discarded, leaving the polychaetes, mainly errantian, and small crustaceans. Large forms, such as echinoderms or decapod crustaceans never occurred in our grab and are therefore discussed below on the basis of their appearance as trawl by-catch. The results thus obtained were as follows:

Area/ Station[a]	Depth (m)	Biomass (wet weight; $g \cdot m^{-2}$) Polychaetes	Crustaceans	Total
4/15	24	1.0	0.2	1.2
4/23	35	0.8	-	0.8
4/31	20	1.0	-	1.0
4/42	35	-	-	-
4/47	34	6.4	0.4	6.8
4/54	13	5.4	0.2	5.6
4/59	35	1.4	0.4	1.8
4/62	32	1.6	0.2	1.8
5/38	36	5.6	0.8	6.4
5/56	42	3.2	-	3.2
5/62	44	2.8	1.6	4.4
5/68	27	5.6	1.0	6.6
5/82	40	1.0	1.4	2.4
5/102	52	5.0	0.4	5.4

[a]See database in Torres et al. (this vol.) for positions, times, etc.

The following observations were made on the macrobenthic bycatch:

Crustaceans: Penaeid shrimps, palinurids, *Thenus orientalis*, and other crustaceans such as brachiurans (crabs) and stomatopods (mantis shrimp) never occurred in commercially relevant concentrations. This is most probably due to the gear used, the depths, and the areas surveyed but it may also indicate an overall scarcity of these resources in the area of the survey. The following penaeid shrimp were found and identified: *Penaeus merguiensis*, *P. semisulcatus*, *Metapenaeus monoceros*, *Parapenaeopsis* spp., *Solenocera* spp.

Echinoderms: except for a tendency for large sea-stars to become entangled in the net, and for ophiudeans and echinoideans to make the deck sticky and slippery, the animals of this phylum seem to represent neither a nuisance nor a resource.

Porifera: During coverage of Areas 4 and 5, large mushroom-shaped sponges (tentatively identified as *Poterion nautilus*) occurred in almost every haul; they were counted, and some of them weighed; a rough average of 40 kg per sponge was estimated.

end of such lines). Steaming between the different station lines occurred in the first night hours, after which the ship was anchored until the beginning of the next line.

The station lines were parallel to the predominant current, and similar numbers of trawl stations were carried out with and against that current.

The method for estimating standing stock size is based on the assumption that there is a direct relationship between catch per unit of effort (i.e., catch/hour trawling) and stock density. Here, the area in km^2 (A) swept by the net in one hour is given by

$$A = 2/3\,(HR)(2.8)(1.85)(10^{-3}) \qquad \text{...1)}$$

where HR is the length of the net's head rope in m (here 36 m), 2.8 is the mean trawling speed of the boat in knots and 1.85 converts nautical miles to kilometers.

Assuming a catchability of 0.5 (Shindo 1973), later confirmed by Pauly (1980) the stock density (D, in $t \cdot km^{-2}$) was determined by

$$D = \frac{kg \cdot hour^{-1}\left(10^{-3}\right)}{A\left(x_1\right)} \qquad \text{...2)}$$

Stations were considered successful when trawling proceeded for one hour without incidents, or when the net was only slightly damaged when retrieved. When trawling had to be interrupted, but the haul was nevertheless considered successful, the catch was made comparable to an hourly catch by application of a multiplicative factor. Stations were considered unsuccessful when the net was badly damaged, torn, or when the otter boards (Fig. 2) were not properly set. The position and details on all stations, including the time (Western Indonesian time), the depth, the catch and/or remarks in the case of unsuccessful stations are given in the database documented in Torres et al. (this vol.).

Sorting of the Catch

The catch of each haul was generally sorted to families, or to genus or species in some cases (Box 3). This work was done by the biologists, who were herein kindly assisted by the ship's crew. The catch of each group was weighed with the precision of 0.1 kg. Weighings were done with an arm balance, not very sensitive to the movements of the boat.

Fish specimens were gathered throughout the survey area for the reference collection of the MFRI, and included in mid-1976, over 750 specimens distributed in 80 families, 146 genera and 231 species (Widodo 1976). The corresponding occurrence records will be part of FishBase 97 (see Froese et al., this vol.)

Box 6. Back and forth fishing experiment.
[Boks 6. Percobaan penangkapan "maju-mundur."]

During the coverage of Area 5, an experimental depletion of the fish stock by means of repeatedly fishing on the same station was conducted, based on a suggestion by Captain P. Jarchau, whose help largely contributed to its relative success. This was to provide information on:

i) how fast an area swept by the trawl is "resettled", hence on how close two trawlers might follow each other when operating; and
ii) the possibility of separating fish groups into "sedentary" and "motile", hence on whether the thinning out of certain fish groups in a given area will affect the nearby areas.

Nine hauls were made by trawling back and forth between two buoys anchored with at a distance of approximately 2.3 nm from each other. The average trawling time was 49 minutes, and all catches were adjusted to the standard of one hour's trawling. The experiment was carried out at the geographical position of Station 110, in Area 5 (i.e., 0°47.6'N; 104°27.0°E).

Six groups, assumed to represent the main behavioral type of "sedentary" and "motile" fishes were selected. Of these, only two showed a decreasing trend over the nine hauls: the sharks, and the rays; the latter of these can safely be assumed to represent the most sedentary of the group below:

Group	Successive densities (kg·hour^{-1})								
	Haul number								
	1	2	3	4	5	6	7	8	9
Sharks	10.1	17.5	7.5	10.1	4.1	4.7	2.0	4.8	3.9
Rays	45.9	48.8	13.2	44.1	20.9	22.7	29.7	20.8	14.3
Clupeidae/Engraulidae	1.5	5.0	0.1	0.8	0.1	0.4	0.2	0.4	2.4
Chirocentrus dorab	0.5	9.1	6.0	1.1	1.4	1.4	0.9	12.0	4.5
Ariidae	0.9	2.0	1.8	2.1	0.2	0.3	0.9	0.7	1.4
Leiognathidae I	61.7	94.1	32.2	6.0	-	-	-	-	-
Leiognathidae II	-	-	-	-	45.3	249.2	50.0	73.1	26.0

The pelagics (Engraulidae/Clupeidae, *Chirocentrus dorab*) were not affected by the back and forth fishing. The Ariidae, surprisingly, also appeared to be very "motile" although they are benthic fishes.

The catch data for the Leiognathidae (*Leiognathus splendens* for more than 90%) first decreased markedly, then rapidly increased, suggesting that a large school entered the fished zone. This school was then depleted by subsequent fishing.

Length-frequency Measurement

A total of over 40,000 fish, belonging to 40 species were measured during the surveys presented here. Most of these measurements are documented in Martosubroto and Pauly (1976) and Pauly and Martosubroto (1980). Pauly et al. (this vol.) present the analyses based on these data, which are also included in the database documented in Torres et al. (this vol.)

Results and Discussion

The measurements of temperature, O_2 and transparency performed in the course of the survey are too scattered to warrant presentation here; they may be found, however, in the database documented in Torres et al. (this vol.). Box 4 documents our observations on the zooplankton in survey area 5, while Box 5 documents the zoobenthos.

Catch Rates, Stock Densities and Standing Stocks

Table 2 shows the numbers of successful hauls in each area and depth horizon (excluding the Malacca Strait, discussed in Martosubroto et al., this vol.). These numbers vary greatly between areas (see also Fig. 4), due to several breakdowns of the ship's main engine. Still, these hauls allowed mapping the catch rates over most of Areas 1-5 (Fig. 5).

The estimates of overall stock density obtained by the swept area method are given in Table 3, by area and depth range. The highest stock density of 5.2 t·km^{-2} occurred in Area 1, between 50 and 59 m, while the lowest density of 0.8 t·km^{-2} occurred, as expected, in the heavily exploited shallow waters off Western Java, i.e., in Area 2 (see also Martosubroto, this vol.).

Table 2. Number of successful hauls by *Mutiara 4*, November 1974 to July 1976[a].
[Tabel 2. Jumlah tarikan trawl yang sukses dari Mutiara 4, *November 1974 hingga Juli 1976.]*

Depth (m)	Area 1	Area 2	Area 3	Area 4	Area 5
10-19	-	1	17	5	13
20-29	-	29	22	25	24
30-39	-	11	11	30	48
40-49	3	24	14	1	50
50-59	17	35	15	-	9
60-69	30	4	6	-	3
70+	-	1	-	-	-
Total	50	105	85	61	147

[a]Excluding Area 6 (Malacca Strait, treated in Martosubroto et al., this vol.).

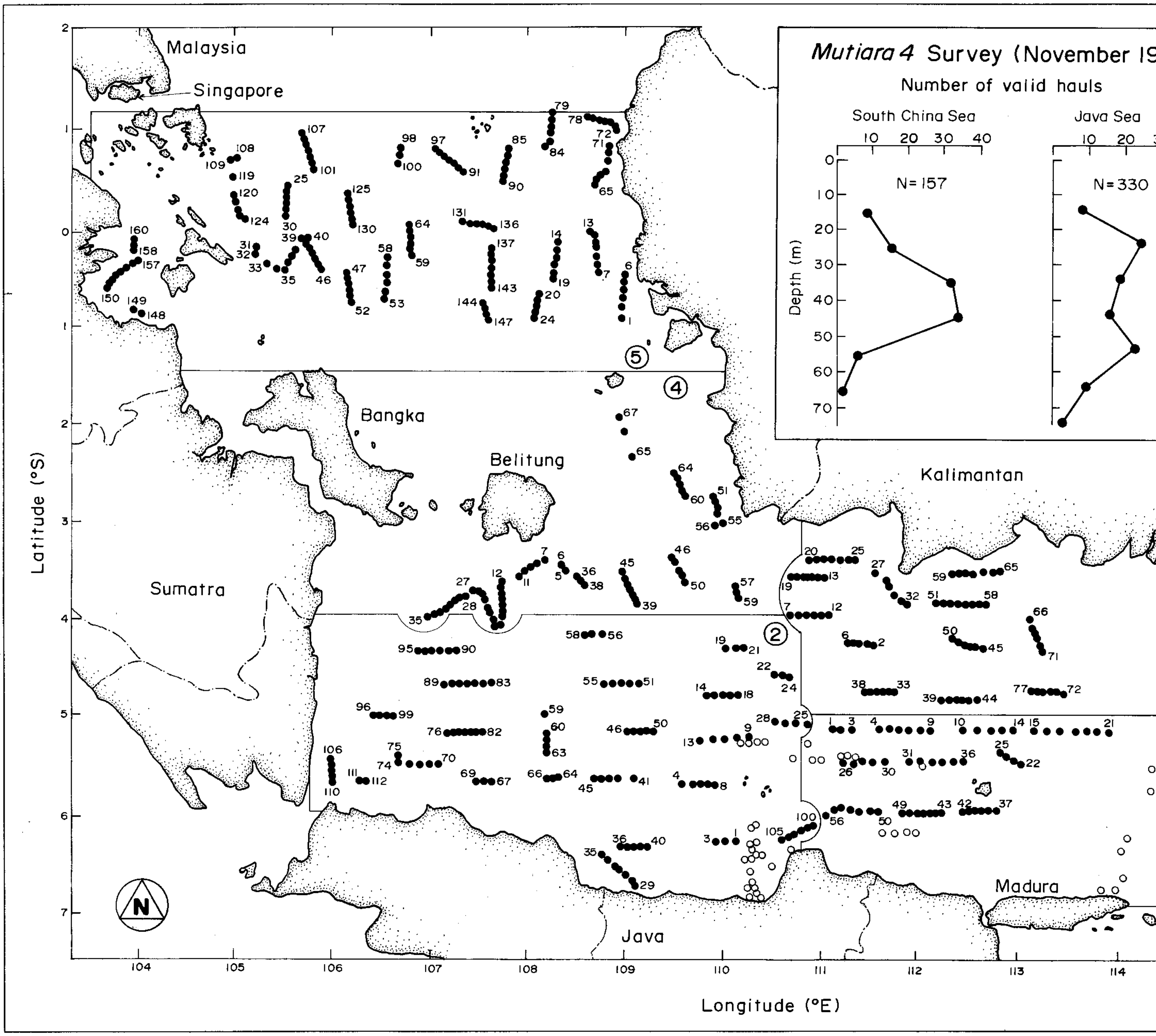

Fig. 4. The station grid of *Mutiara 4*, November 1974 to July 1976 (excluding the Malacca Strait, treated by Martosubroto et al., this vol.).
[Gambar 4. Stasiun pengambilan contoh kapal Mutiara 4, *November 1974 hingga Juli 1976 (tidak termasuk Selat Malaka, dibahas dalam Martosubro*

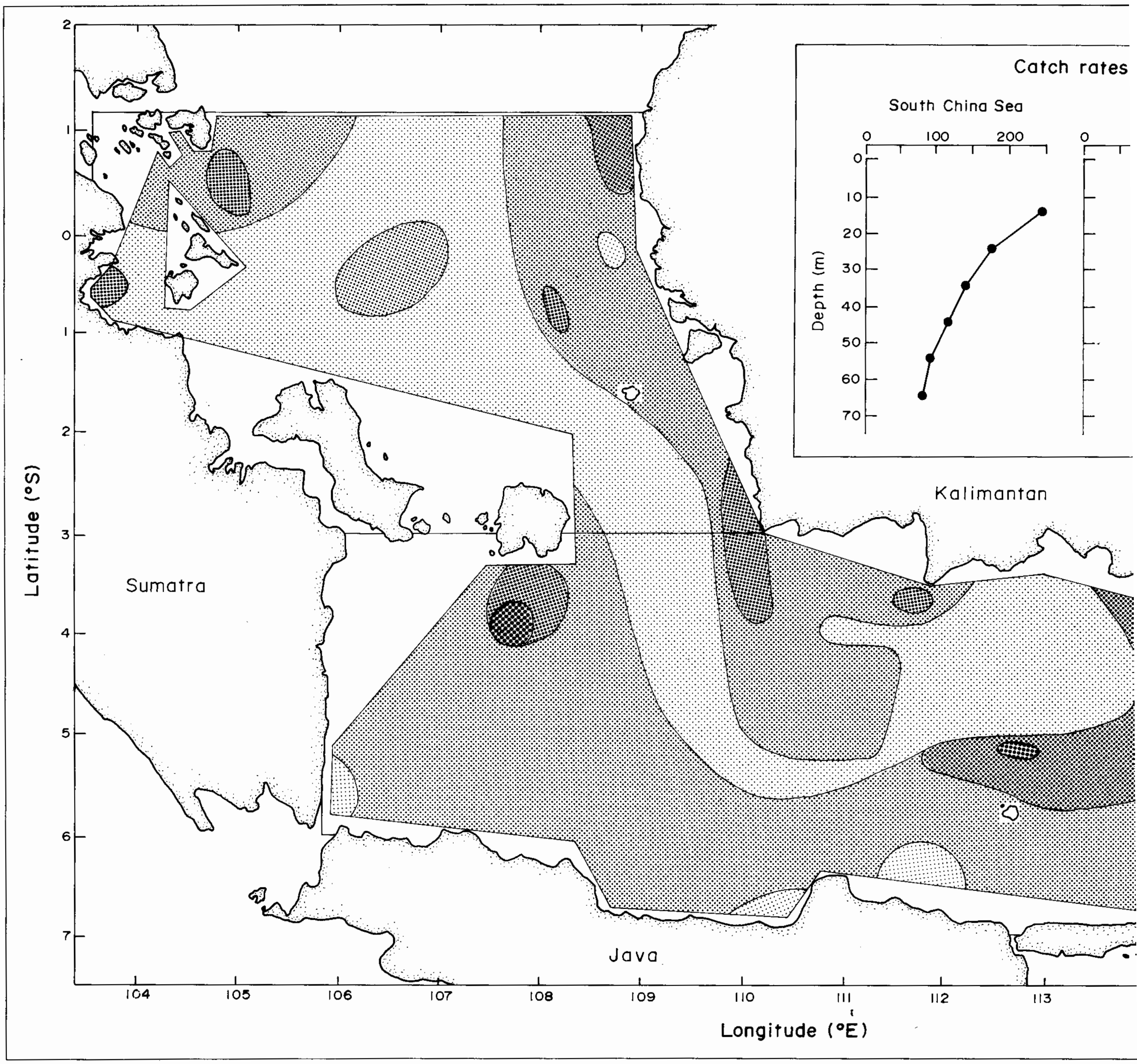

Fig. 5. Distribution of catch rates (kg·hour^{-1} of *Mutiara 4* November 1974 to July 1976 (excluding the Malacca Strait, treated by Martosubroto et al., th
[Gambar 5. Sebaran rata-rata hasil tangkapan per jam tarikan trawl dari Mutiara 4, *November 1974 hingga Juli 1976 (tidak termasuk Selat Malaka, di*

Table 3. Mean density (in t·km^{-2}) of demersal fish as estimated by the swept area method for the period from November 1974 to July 1976[a].
[Tabel 3. Estimasi kepadatan rata-rata (dalam km^2) sumberdaya ikan demersal berdasarkan methode dalam kurun waktu November 1974 hingga Juli 1976[a].]

Depth (m)	Area 1	Area 2	Area 3	Area 4	Area 5
10-19	(3.0)	0.8	2.1	4.8	3.4
20-29	(2.5)	2.7	2.4	4.3	2.8
30-39	(1.9)	2.4	2.5	2.1	2.3
40-49	3.2	2.2	2.2	1.4	1.8
50-59	5.2	1.9	1.6	-	1.4
60-69	3.4	1.9	1.5	-	1.2
70+	(1.5)	1.5	-	-	(1.5)
Biomass[b]	362	272	259	388	389

[a]Excluding Area 6 (Malacca Strait, treated in Martosubroto et al., this vol.).
[b]In t·10^3.

From the density data, the standing stock (biomass) for each area and depth range was calculated, based on the surface area of the various depth ranges in Table 1. We abstain here from presenting more than the sum of these estimates, by area (Table 3, last row).

In Saeger et al. (1976), "Gulland's equation" i.e., (Potential yield = 0.5*M* unexploited biomass; Gulland 1971) was used to derive potential yield estimates from the biomasses in Table 2, and M = 1 year^{-1}. Then, the number of trawlers was estimated which would be required to harvest this yield, and rough estimates of the value of their potential catch were presented - the point being to assemble all the elements required for assessing the prospects for the development of trawl fisheries.

The demersal fisheries did develop - so fast, indeed, that trawling was banned a few years later (Sardjono 1980). Pauly (this vol.) discusses this, and the new uses to which the data we gathered (documented in Torres et al., this vol.) can be put; Pauly et al. (this vol.) discuss the biology of some of the fish species surveyed by *Mutiara 4* and other research vessels, while Martosubroto (this vol.) and Bianchi et al. (this vol.) discuss the structure of the assemblages formed by these fishes.

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Demersal Assemblages of the Java Sea: A Study Based on the Trawl Surveys of the *R/V Mutiara 4*

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Abundance
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Abstract

An attempt is made to analyze the data collected through the trawl surveys conducted in the Java Sea by *R/V Mutiara 4* to detect patterns of species associations and of seasonal variation in abundance. The analyses based on the data collected through the first survey period (1974-1976), by large categories and including an undetermined number of species, could - at the family level - only confirm the homogeneity of the area surveyed. Data from the second survey period revealed differences at the species level, allowing the division of the Java Sea communities into at least three major groups: assemblages of the central and of deepest part of the basin (depth >30 m) and assemblages of the shallow coastal waters, where major differences appear to be due to the presence of estuaries. Seasonality is another important structuring factor: southeast monsoon catches were over two times higher than northwest monsoon catches, and less variable.

Abstrak

Analisis terhadap data yang terkumpul dari survei trawl di Laut Jawa oleh kapal penelitian Mutiara 4 dilaksanakan dalam rangka melihat bentuk asosiasi spesies dan variasi musiman dari kelimpahannya. Analisis terhadap data yang dikumpulkan dalam periode survei pertama (1974-1976), berdasarkan pengelompokan kasar termasuk beberapa spesies yang belum teridentifikasi, - pada tingkatan famili - hanya mampu memperkuat adanya keseragaman jenis di daerah survei. Data dari periode kedua menunjukkan adanya perbedaan pada tingkat spesies yang mana hal tersebut dapat dipakai untuk membagi komunitas di Laut Jawa menjadi tiga kelompok besar: yakni kelompok di daerah pertengahan dan daerah yang dalam (kedalaman > 30 m), serta kelompok di daerah yang dangkal, dimana perbedaan tersebut adalah akibat pengaruh estuari. Pengaruh musim juga merupakan faktor penting: hasil tangkapan pada waktu musim angin tenggara tercatat dua kali lebih tinggi daripada waktu musim angin barat laut, dan memiliki fluktuasi hasil tangkap yang lebih kecil.]

Introduction

The present study utilizes data collected by the *R/V Mutiara 4* through the survey program started by the Indonesian-German Demersal Fisheries Development Project in 1974. The surveys aimed to evaluate the abundance and distribution of the demersal fishes of Indonesia. They took place in two survey periods: one between November 1974 and June 1976, devoted to a single coverage of Western Indonesia and another in June 1976-1979, which consisted of several coverages of the Java Sea. Various cruise reports were produced, including descriptions of the data collected and analyses of catch composition, biomass estimates and potential yields (Martosubroto and Pauly 1976; Saeger et al. 1976; Losse and Dwiponggo 1977; Dwiponggo and Badrudin 1980). Pauly et al. (this vol.) presented an account of the methodology and main results obtained from the surveys of the *R/V Mutiara 4* in 1974-1976 while Martosubroto (this vol.) analyzed the changes that have occurred in the composition of the demersal resources of the Java Sea in the period 1975-1979. This study follows up on this with an attempt to identify the major fish assemblages of the Java Sea, and to identify some of the environmental factors shaping them.

Table 1. Survey effort by region and period (arranged chronologically). NW: northwest monsoon; SE: southeast monsoon. *[Tabel 1. Kegiatan survei menurut daerah dan waktu (disusun secara kronologis). NW: musim angin barat-laut; SE: musim angin tenggara.]*

Dates Survey area	Season	From	To	No. of stations
Survey period: November 1974 to June 1976[a]				
Central and East Java (Leg I)	NW	17.11.74	18.12.74	56
South China Sea (Leg V)	NW	31.01.75	02.02.75	13
Malacca Strait (Leg VI)	NW	09.02.75	21.02.75	41
Central and West Java (Leg II)	SE	29.04.75	26.06.75	112
South China Sea (Leg V)	SE	09.08.75	16.09.75	147
Karimata Strait (Leg IV)	SE	07.11.75	11.12.75	62
South Kalimantan (Leg III)	NW	19.03.76	22.06.76	80
Survey period: July 1976 to December 1979[b]				
East Java Sea (Areas H & G)	SE	15.06.76	24.06.76	25
East Java Sea (Areas H & G)	SE	21.07.76	29.07.76	23
Central Java Sea (Areas E, F, C, D)	SE	04.08.76	13.08.76	28
Central and West Java Sea (Areas A, B, E, C)	SE	03.09.76	10.09.76	30
West Java Sea	SE	17.09.76	22.09.76	19
Central and East Java	NW/SE	20.01.77	12.10.77	112
Central and East Kalimantan	SE	14.10.77	07.11.77	37
Central, East and West Java	NW	28.11.77	21.12.77	82
Central Java	NW	10.01.78	11.01.88	7
Southeast Sumatra	NW	13.01.78	19.01.78	29
Central and East Java	SE	19.05.78	24.11.78	99
East Kalimantan	NW	27.12.78	01.01.78	46
West and Central Java	NW	12.01.79	19.01.79	44
Southeast Sumatra	NW	02.02.79	07.02.79	26
Central, East and West Java	NW	07.02.79	24.05.79	108
West Kalimantan	SE	14.06.79	19.06.79	30
Southeast Sumatra	SE	21.07.79	25.07.79	27
East Kalimantan	SE	10.08.79	13.08.79	20
East and Central Java	SE	05.09.79	10.09.79	37
Central Kalimantan	SE	20.09.79	25.09.79	33
Central Java	SE	12.10.79	18.10.79	41
Southeast Sumatra	SE	25.11.79	26.11.79	6

[a]Including stations considered unsuccessful.
[b]Excluding gear tests and aimed fishing.

Materials and Methods

Table 1 presents an overview of the surveys by *R/V Mutiara 4* during the period 1974-1979, by region and season. The area covered by the project is presented in Pauly et al. (this vol.) and Martosubroto (this vol.) for the periods 1974-May 1976 and June 1976-1979, respectively. Fig. 1 presents the position of the trawl stations for the latter period. From 1974 to May 1976, the southern part of the South China Sea, and the Malacca and Karimata Straits were also surveyed besides the Java Sea, while the area of operation was later limited to the Java Sea. The sampling design and the taxonomic levels used to identify the catches varied between the two survey periods. From 1974 to 1976, identifications were carried out at family level, including about 30 families, in addition to such broad groupings as "sharks," "rays" or "trashfish". From mid-1976 on, fish identification was much improved and species categories were included, leading to a total of 117 systematic and other groups (see Table 2 and Pauly et al., this vol.).

The sampling design during the period 1974-1976 consisted of tracks, usually parallel to the coast, with sets of stations very close to each other (cluster sample approach). The observations collected with this type of sampling design have the drawback of nonindependence and autocorrelation between the cluster of observations, a feature that is problematic when biomasses are to be estimated (Gunderson 1993). This problem was dealt with by using, for our community analyses, only a subset of all stations, obtained by extracting the most distant stations from each track, for the whole area.

The second survey period (June 1976 to 1979) also involved variable survey designs. During the first three months, June-September 1976, a systematic and complete coverage of the Java Sea (Fig. 1) was performed. Successive surveys did not follow an explicit survey design, with stations mainly in shallow coastal areas and "clumped" in some areas as off Southeast Kalimantan and Central Java (Fig. 1). The analysis of community types is thus based on the quasi-synoptic survey of the period June-September 1976. Nonvalid stations, i.e., cases when the gear was damaged, or aimed stations (fishing trials) were excluded from all analyses.

The analysis of seasonal differences in catch rates is based exclusively on stations near Tanjung Selatan, Southern Kalimantan, i.e., from the only area of the Java Sea where

Table 2. Systematic and other groups used for classification of the catches during the *R/V Mutiara 4* surveys. Numbered names indicate the 42 categories used for sorting the catches from 1974 to mid-1976; the other names are the taxa added to the initial list in mid-1976.
[Tabel 2. Kelompok hasil tangkapan (menurut sistimatika dan grup lain) dari survei dengan kapal penelitian Mutiara 4. *Tercatat ada 42 kategori yang dipakai dalam pengelompokan hasil tangkapan tahun 1974 hingga pertengahan 1976; nama-nama yang tidak pakai nomor adalah yang ditambahkan pada pertengahan 1976.]*

1. Sharks
    - *Carcharhinus sealei*
    - Other sharks
2. Rays
    - Dasyatidae
    - Other rays
3. Ariidae
    - *Arius coelatus*
    - *Arius maculatus*
    - *Arius thalassinus*
    - *Arius venosus*
    - *Osteogeneiosus militaris*
    - Other Ariidae
4. Balistidae
    - *Abalistes stellaris*
5. Carangidae
    - *Alectis* spp.
    - *Alepes* spp.
    - *Atule* spp.
    - *Atropus atropus*
    - *Carangoides* spp.
    - *Caranx* spp.
    - *Decapterus* spp.
    - *Megalaspis cordyla*
    - *Selar* spp.
    - *Selaroides leptolepis*
    - *Seriolina nigrofasciata*
    - Other Carangidae
6. Chirocentridae
7. Clupeidae
    - *Anadontostoma chacunda*
    - *Dussumieria acuta*
    - *Ilisha* spp.
    - *Sardinella* spp.
    - Other Clupeidae
8. Drepanidae
9. Engraulidae
    - *Stolephorus* spp.
    - *Thryssa* spp.
    - *Setipinna* spp.
    - *Coilia dussumieri*
10. Formionidae[a]
    - *Formio niger*[a]
11. Gerreidae
    - *Pentaprion longimanus*
    - Other Gerreidae
    - Heterosomata
12. *Psettodes erumei*
13. *Lactariidae*
14. Leiognathidae
    - *Gazza minuta*
    - *Leiognathus brevirostris*
    - *Leiognathus bindus*
    - *Leiognathus daura*
    - *Leiognathus elongatus*
    - *Leiognathus equulus*
    - *Leiognathus splendens*
    - *Leiognathus smithursi*
    - *Secutor insidiator*
    - Other Leiognathidae
15. Lutjanidae
    - *Lutjanus johni*
    - *Lutjanus sanguineus*
    - Other Lutjanidae
16. Mullidae
    - *Upeneus bensasi*
    - *Upeneus sulphureus*
    - Other Mullidae
17. Muraenesocidae
18. Nemipteridae
    - *Nemipterus bathybius*
    - *Nemipterus hexodon*
    - *Nemipterus japonicus*
    - *Nemipterus marginatus*
    - *Nemipterus mesoprion*
    - *Nemipterus peronii*
    - *Nemipterus tolu*
    - *Scolopsis* spp.
    - Other Nemipteridae
19. Pentapodidae
20. Polynemidae
21. Pomadasyidae
    - *Pomadasys argyreus*
    - *Pomadasys hasta*
    - Other Pomadasyidae
22. Priacanthidae
    - *Priacanthus macracanthus*
    - *Priacanthus tayenus*
23. Rachycentridae
24. Sciaenidae
25. Scombridae
    - *Rastrelliger* spp.
    - *Scomberomorus* spp.
26. Serranidae
27. Stromateidae
    - *Pampus argenteus*
    - *Pampus chinensis*
28. Sphyraenidae
    - Sphyraena barracuda
    - *Sphyraena jello*
    - Other Sphyraenidae
29. Synodontidae
    - *Saurida longimanus*
    - *Saurida micropectoralis*
    - *Saurida undosquamis*
    - Other Synodontidae
30. Terapontidae
31. Trichiuridae
32. Other foodfish
33. Trashfish
34. Squids
35. Cuttles
36. Shrimps
37. Crabs
38. Lobster (*Thenus* sp.)
39. Other invertebrates
40. Snakes
41. Turtles
42. Sponges

[a]Now put within the family Carangidae (Nelson 1994).

trawl stations covering several years were available for both seasons (southeast monsoon: 1977-1979; northeast monsoon: 1978, 1980 and 1982-1984).

The methods used to identify patterns of species association include multivariate analysis techniques of ordination and classification type. They are the same as those described in Bianchi (this vol; see also McManus, this vol.).

Study Area

The study area includes the Java Sea and a part of its connection to the southern South China Sea, i.e., the southern Karimata Strait. This region is part of the triangle bounded by the Philippines, the Malay Peninsula and New Guinea, characterized by the extraordinary richness of its marine fauna. Although there are a few species unique to this region, the total number is higher than in other similar areas of the world (Ekman 1953). The reasons for the high diversity are usually related to climatic stability at various time scales and the "effect of area," the availability of large shelf areas with favorable conditions for speciation through eustatic sea level changes (see Sharp, this vol.; McManus, this vol.).

The area studied is mostly shallower than 100 m, with rather stable conditions, although under the influence of the monsoon regime. The southeast monsoon blows from April to November and reaches its peak in June-September. The northwest monsoon blows the rest of the year, with peaks in December-February. The main changes in the oceanographic conditions entail a major westward movement in the Java Sea during the southeast monsoon. Surface salinities vary from 33 to 36 but are noticeably lower near the shores of Sumatra, Kalimantan and Java because of local runoff. Here the waters are also less transparent because of the fine sediments transported with the fluvial outflow. Temperatures vary little from 27 to 29°C (see Roy, this vol.).

During the northwest monsoon (December to February), the general transport is eastwards and low-salinity surface waters from the China Sea enter the Java Sea. The heavy rains and increased runoff from the rivers in Sumatra, Kalimantan and Java contribute to the further decrease in salinity in this season.

Unfortunately, comprehensive coverages for both monsoon seasons were not available; hence the limitation, for the interseason comparison, to a small area of the Java Sea (see above and Fig. 1).

Results

Fig. 2 shows the result of the TWINSPAN analysis based on a subset of stations from the survey period November 1974-May 1976, while Fig. 3 shows the location of the stations of Group 2 generated by this analysis.

Fig. 2 indicates a general uniformity in the composition of the major families in the trawl catches. The main difference identified by the first TWINSPAN division is between the very shallow waters (depth 10 to 25 m) in proximity of river outlets and the remaining stations (depth 25 to about 70 m). All taxa found in the deeper range were also present in shallow waters, except for the family Balistidae. Also, a few taxa appeared to be restricted to shallow areas. These include both small pelagic species (Engraulidae and Clupeidae), and demersal species of the family Sciaenidae and Drepanidae.

The set of 119 stations from the survey period June-September 1976 fully covered the area under study and were sampled within one season, during the southeast monsoon. Figs. 2 and 4 show the results from the TWINSPAN analysis and the plot of the above stations on DCA axes 1 and 2, respectively Fig. 3. The first division resulting from the TWINSPAN analysis shows the presence of two major groups: a shallower, with average depth of 27 m, and a deeper one, with average depth of 43 m. The former group has as indicator species *Dussumieria acuta, Ilisha,* Sciaenidae and *Leiognathus splendens*. The other group corresponds to the deeper part of the Java Sea basin. Althought many taxa are common with the shallow group, the deepwater stations do not have consistent indicator species mentioned above, or their presence is less consistent.

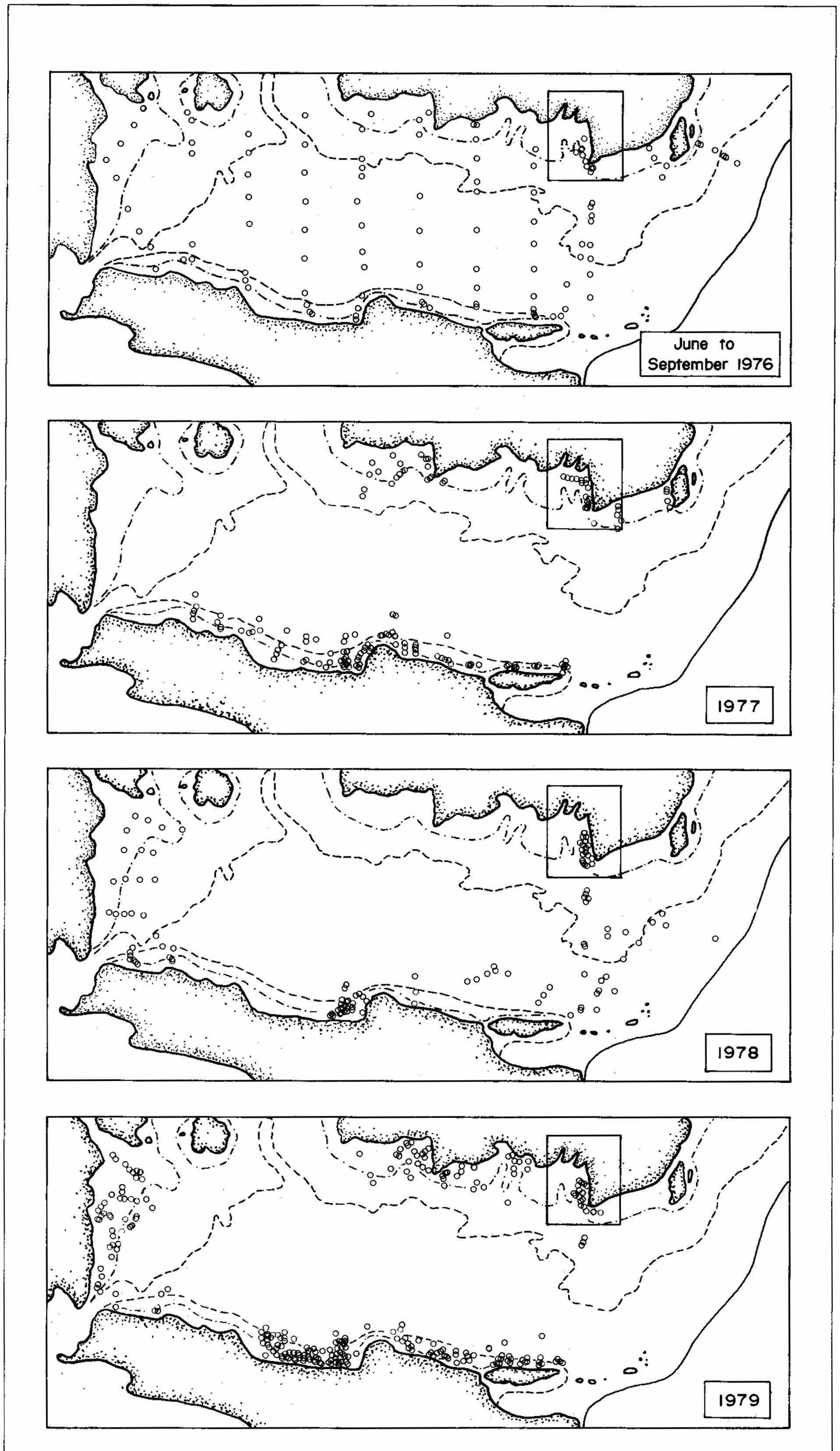

Fig. 1. Trawl stations of the Java Sea surveys conducted by the *R/V Mutiara 4* from June 1976 to December 1979 (fishing experiments not included); (dotted line - 20 m; dashed line - 40 m; solid line - 200 m). The box around Tanjung Selatan shows the stations used for between-season comparisons of catch rates.

[Gambar 1. Stasiun pengamatan survei Mutiara 4 *di Laut Jawa dari Juni 1974 hingga Desember 1979 (tidak termasuk percobaan penangkapan); (garis bertitik - 20 m; garis terputus - 40 m; garis - 200 m). Kotak di sekitar Tanjung Selatan menunjukkan stasiun pengamatan yang dipakai untuk membandingkan hasil tangkapan antara dua musim.]*

	Group 1 (> 25 m)	Group 2 (10-25 m)
Balistidae	51322541124223321-111121121-1142-32133--3-2-1------	---1----4-----------------1------------
Priacanthidae	--2-13-1122131131------113221---1124-3-11314123-5--	----13411--12-11-11---1------1-------
Gerreidae	--121--1-3--1-31--2-----111-11---4211--1231-3355554	--11--51---52432----211-33--1--------
Lutjanidae	44354554255155334231-1321332-3-2112--31151441-3--21	55-41-3-14---1-1-122--1--------------
Nemipteridae	2112-5422323323411311-341321-1-21332233334455414142	211143423132--22412-111---1211-2-----
Synodontidae	-11211-112122122111--1111111111-111111111-1112321-	1-11112221311-11-1---11111-1111-1----
Serranidae	223-----1-111--1-11----11-1------1-------34--------	21--1-1--1------------------1---------
Scyllariidae	--1--1--11--111-1-1111-11111--11-1111-11--111-1-1--	-----1-----11-1---1----1--------------
Unidentified	-13-231133323234312353545555 1-335332531331333---2--	221511225---3-13251-1-1--111211-25511
Pomadasyidae	5-41-4554234554-542---211-233--2233--232444 4313----	542214224-1--221---2-2111-1-1-224---2
Mullidae	22411122121322231141123312311311-31315332-55224432-	2412555554424334-113311-112411-44----
Loliginidae	13111--112111-111-1111211221212-112111332112 1142444	1212-2232-311313212432111231111-111--
Carangidae	--2212-211112211111-11111212-21342245552453 43323455	531343512322233343354343221111 42113--
Ariidae	1-21114312--21354421--2222433--54233231-2--1111311-	---545345-22121211--214411--13-441311
Sepiidae	--1--1-1-1111-11--1----111-1----11-1--111111------	1--1211--321---11111---1-11--1-------
Sharks	525--1--1--3-1-------------1-42543523-----------21	--1-22-11343-5-1452----12---35-212311
Sphyraenidae	--1---------------------1------1-1--15131-1-11----	124-512-1---1-------1-111111---11----
Psettodes	----------------------------------4--------1----	1--1-1111-1-1---1--------1-1-2-------
Leiognathidae	---11--1-1111-1---1-1111--1--1--1311-12--112-45243-	555555525-555413-54-23123155553221114
Trichiuridae	---21-1--------------------1-1--12---------11------	1122111-1222121--1-4-22-4142-145-42-1
Terapontidae	---------------1----------------------------------	4--1312-1-1-----355121-2--1--42-11-11
Polynemidae	---2--	-----1-1---------1-1-------1121-3----
Engraulidae	---------------------------------------1-------	--221-312-2215-15-14-55232-3153555554
Clupeidae	-------------1-----------------------1------------	24-51451352-4411351525535335254255524
Shrimp	-----------2--------------------------------------	1-111--1------1-11--1-11--11111142211
Stromateidae	--	13-1-----211--1--1---111--52113315511
Drepanidae	--1-------11-----------------------------1-----	54553-111----------1----1111-11-1----
Lactariidae	-----1------------------------------1------------	1--1----1--1----1---2-2----1---------
Sciaenidae	---------------------11-----1-1---------11--------	25-255221-21-112-114-111115512-242211
Chirocentridae	---1----------------------1----------------1------1	111--1-1-31-3--2111-122--1111-1--13--
Parastromat	-----1----1-----------------2-------1-----5-------	---2----1--11---21--11-122-11-11-1---
Scombridae	--2--1-----1-1--1---1-1---1---1---1--1-----1-------	12121-121121221-2144332321111--------
Crabs	-----------------1---1--1---1------------11------	-------------------------1---1-2-1---
Rays	--55---22--22534-1-1---11-1-----1----1--21221------	4415--323---1-32----213---545---55555

	Group 1 (36 m)	Group 2 (50 m)	Group 3 (26 m)	Group 4 (29 m)
Lutjanus sanguineus	-55-2-----1155-1111--	55432333521-312-1--3-42--312231-312-42143	------255--23-1----1--55-41-21-2-----55---	1----21--335---
Pentaprion longimanus	--21421--1--5-111234-	2455514444-5445535-32554335455 25455551333	11-----1-4-2231145411544-5---11-1---113---	-----1355545-1-
Upeneus sulphureus	1-1-------3-4-14-1--1	545553455235345112553545121545155 55452-55	54-45153545555135-5235555512-11-33451344-1	11-111255535-35
Sponges	1-------3432-43-4333-	---------------1--2--------------------	------3------1--------------------------	---------------
Pentapodidae	-23133313132552323141	-3-3222232211-1212--1--1-14121---1-------	---11---4-1--1--------------------------	---------------
Abalistes stellatus	-4--4333425355341541-	15333332441223211--2------41211-322-1114-	------3-23-224--14---22--2-----------1---	---------11--1-
Other mullids	1---33211131-4-423254	-1-12---1----1-211--1-1---11-11----------	-33313--------1-1----11-3--11-------3----	-11---111------
Other lutjanids	--15312--25155-4111--	-5-333312-1-12-11--2--1-1-1-121---2--13--	------243----1111--2--15--2----3--25-55---	---------4-----
Selaroides leptolepis	11-254155-525553133-5	------112233-541-1-11-11222-111-1------52	-3452554333--21-1--11-231411---11-----1---	-----1121111-11
Carcharhinus sealei	-532-5---33----------	-----32-3------------2----4----3355-2225	4-----235-2221-2------2----------2---21--	-11-41-12------
Arius thalassinus	--5-5131-52-2-21---4-	---112---1----11----1212332--1-12-3-43342	---1--424-24-5552-42-1-13-------3-------	------2--------
Squid	13123----132441112441	134421111123225 2113--------------211541222	1111211232-1121-1-111212141415422-321551--	1--------------
Other foodfish	-55-----1331251-15114	-332211-211-12-3-1------------1211-11421	2111223-13--141111-11--414115--51-11222-55	1--------------
Trashfish	122-5---3223455555151	1454321312523432313 3-----------2343422251	1253-32-23-1221335313343535455424-3411-2-2	1--------------
Other carangids	153232-31351541113331	-333212144122121-2322221413444-2134-31245	421221544514224-5-5224444553534551444541--	313213222542121
Dasyatidae	---2----11-153221-1-1	---5---13----1-----2----112--1--1--------	55-131---21-2-312--1122--55-5-55---5-555--	455-11-5531---1
Other leiognathids	111-121111112---11-13	--5551-55133534--141455543125513-5432111-	1114523434511314155115554533552314541555-1	122115142433-15
Other ariids	-5-14--3-------------	-23---223--1-33----2---42-443----221-----	---------5--3--12-1-2-121-533---5555555445	1--1153213-3---
Rastrelliger spp.	-4-12---1-215----11-1	-------1-112--1--1------------11---1-214	--412-14113-5-1-3--111111-2--------21-4---	1-------------3
Psettodes erumei	----------1----111---	-------11-------------------------1--1-11122	--------1---21--122-1--11-11-----1-121---	---------------
Lobster	--------1-11-211111-1	------1---2--1---------------------1-1--1-	1323211-----1---1-21111---2----1-1--1----	---------------
Other rays	52---4-----5---------	-4-------------------1---1--------12----	-----1----1--3-44------21--1--55-452-43--1	---------------
Cuttlefish	1---1-------11-111121	---111----1---11-11------------1-11-1-	3422423--3-11--11-11--111424-2233--1-1----	---------------
Trichiuridae	111-------1-22------1	3131---11--1-----2-------------241--1351	1-525--13114513312411334-3-1-24-512212415-	---------------
Chirocentridae	----------1----------	--------1---------------------------1------	2-------1------21-----------1--1----1-----	-12111-311-----
Clupeidae	-1-------------------	-----------------------------1------------	---5--	-----------4---
Scombridae	--------1------------	---------------------------------------21-	---------------------------------3------	-2121112---1---
Formio niger	------------1-----1--	----------------------------211-------2	-------1-4---1----------4---------1211----	---------------
Sardinella spp.	---1-------1---------	---4	------1121---31-1------1--1---2-1-33244---	2--------11-11-
Other engraulids	---------------------	----------------3----------------1-----	------------------------------------1--1--55-	------------11-
Stolephorus spp.	---------1--1--------	------------1------1-1-1-------1-2111111-1	--------5---1251-14-35-51511455-115214513-	1--------51-1--
Drepanidae	---------------------	-------22-----------------------------1-----	-------------------1-----1----2-2551551--	---------1-----
Other sphyraenids	---11----21-------2-1	------------1--11--------------------2-1--1----	-2112-22242--121--1-1123312-------42234---	------------1-1
Terapontidae	1--------41--------2	---4-----------------------------------1---11---	---213-2314111-1--1-1-1--4114-124-1121323-	------------1-3
Pomadasys argyreus	--------141----------	--4-	------311--1142------------------4433-----	---------------
Dussumieria acuta	---------------------	---------------------1--1------------1-1-----3	311-415154--2112-1--11-11---432-3-54145---	1-1113---24-21-
Ilisha spp.	---------------------	------------------------------1--------------	------5122-3-25--421---43515431-2-32322552	1---133--1-41--
Sciaenidae	---------------------	-------------1-----1---------------311-------	22--144---1-211223111-132543-----412544433	313111111--11--
Leiognathus splendens	--------------------3	--------------------1----1------11---------	1114125255515153455155545 1-422--5454551-1	222-55142453-15
Other clupeids	---------------------	----------------1------------1----------------	------------55--------2---5-5----2511--2151	---------4--11-
Polynaemidae	---------1-----------	--	1----12-----------------111511------2--223-1	-3-------------
Crabs	-------------------11	--------2---------------------------------	14331--------1-----------------22111---13---	---------------
Shrimps	-------------------11	--------------------1---1-------------------1----	34121-------1-1-1-------13-1111-1131-11452	---------------
Lactarius lactarius	---------------------	--	------1----1112---1---211-11-----11-3-----	------------1--

Fig. 2. Dendrogram of the Java Sea communities resulting from TWINSPAN analysis of R/V *Mutiara 4* data. Above: 1974-May 1976. Below: June-September 1976 (note that only part of the stations used for the analyses are shown).

[Gambar 2. Dendrogram komunitas ikan di Laut Jawa berdasarkan analisis TWINSPAN terhadap data Mutiara 4. *Gambar atas: 1974-Mei 1976. Bawah: Juni-September 1976 (perlu diketahui bahwa hanya sebagian dari stasiun pengamatan yang dipakai untuk analisis).]*

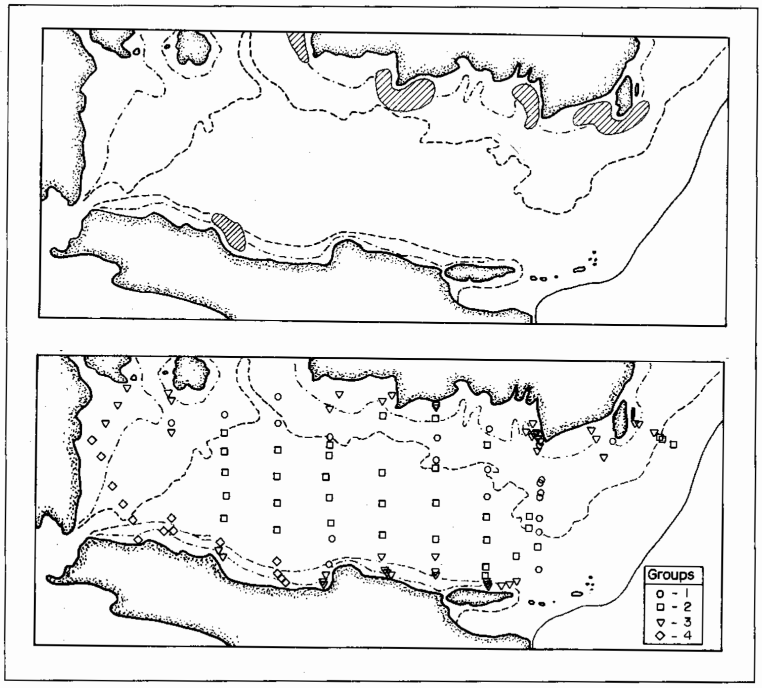

Fig. 3. Division of the Java Sea fish communities identified by TWINSPAN analyses. Above: November 1974-May 1976, with the shallow areas identified as a separate group (Group 2, top of Fig. 2). Below: TWINSPAN Groups 1-4 superimposed on stations for period June-September 1976.
[Gambar 3. Pembagian komunitas ikan di Laut Jawa berdasarkan analisis TWINSPAN. Gambar atas: November 1974 - Mei 1976, dengan daerah dangkal teridentifikasi sebagai suatu kelompok terpisah (Grup 2, bagian atas Gambar 2). Gambar bawah: TWINSPAN Grup 1-4 yang ditumpang-tindihkan pada lokasi stasium pengamatan periode Juni-September 1976.]

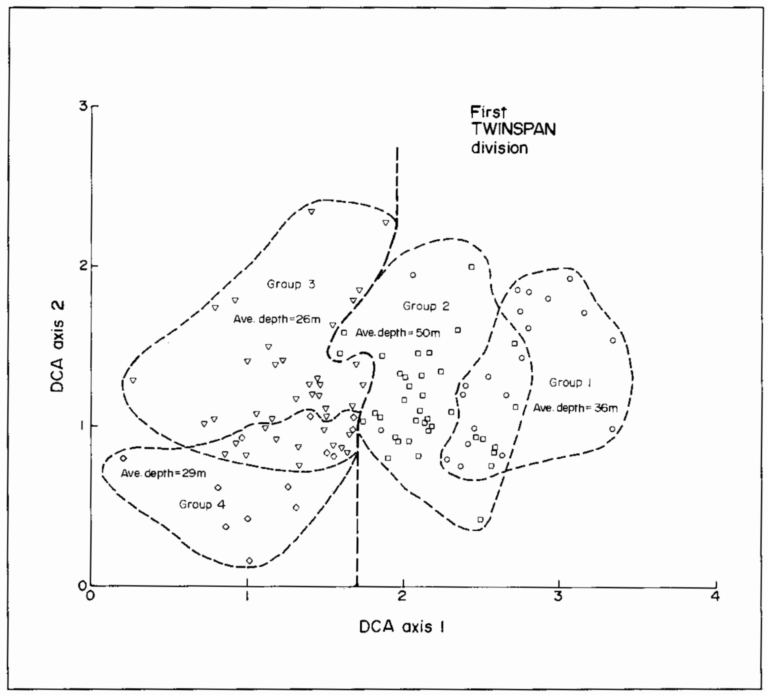

Fig. 4. Plot of the stations on DCA Axes 1 and 2 for the survey period June-September 1976. Numbers indicate the TWINSPAN groups defined in the text.
[Gambar 4. Plot dari stasiun-stasiun pengamatan pada sumbu DCA 1 dan 2 untuk periode survei Juni - September 1976. Angka-angka menunjukkan grup TWINSPAN sebagaimana dibahas didalam tulisan.]

Table 3. Catch rates in kg hour^{-1} of *R/V Mutiara 4* in the waters near Tanjung Selatan, South Kalimantan, by season and year.
[Tabel 3. Hasil tangkapan per jam tarikan trawl oleh Mutiara 4 di perairan sekitar Tanjung Selatan, Kalimantan Selatan, menurut musim dan tahun.]

Monsoon	Southeast			Northwest				
Fish group/Year	1976	1977	1979	1978	1980	1982	1983	1984
Ariidae	38	87	64	24	31	11	12	17
Carangidae	13	14	7	4	19	1	8	14
Clupeidae	56	30	35	22	41	8	10	13
Drepanidae	12	27	45	14	2	-	4	20
Leiognathidae	77	122	82	11	53	7	39	87
Lutjanidae	16	14	23	13	8	7	3	6
Pomadasyidae	15	25	32	13	20	6	6	11
Rays	25	66	41	19	31	43	-	37
Other fish	104	90	68	29	58	23	31	40
Total	356	475	397	149	263	106	113	245

Other species, such as *Lutjanus malabaricus* (non *sanguineus)* and *Pentaprion longimanus,* are relatively more abundant in the deepwater group (Group 2). This division is confirmed by the DCA analysis; the groups, although widely overlapping, do show some identiy. Sponges, characterizing Group I, were trawled in the depth range 20-40 m, in association with sandy bottoms and particularly in the depth range 30-40 m off South Kalimantan. The separation between Groups 3 and 4 is more difficult to interpret: Group 3 represents well the rich fauna of shallow inshore waters, including areas influenced by estuarine environments, but Group 4 appears to be less simply diverse. The stations of this group are geographically close to each other which might indicate that different ecological conditions as responsible for this separation. However, given that there are no indicator species and this group is mainly identified by a lack of taxa, it might well be that this difference results from the incomplete identification of the catches.

Table 3 presents a summary of mean catch rates (total and by major taxonomic groups) by year and seasons. The grand mean southeast monsoon catch rate in the period 1977-1979 was 409 kg·hour^{-1} (SD: 60.5 kg·hour^{-1}); the grand mean northwest monsoon catch rate in 1978-1984 was only 175 kg·hour^{-1} (SD: 75.2 kg·hour^{-1}). Table 3 also suggests shifting patterns of dominance, with, e.g., the Leiognathidae always dominating during the southeast monsoon, but only in one out of five seasons during the northwest monsoon.

Discussion

The data from the first survey period hardly allow a community study, mainly because of the rough taxonomic categories used to identify the catches. The results obtained reflect the uniformity in the distribution at family level in the study area and the lack of environmental barriers, with the exception of the inshore waters influenced by the estuarine environment. A better resolution was obtained by the analysis of the quasi-synoptic survey in June-September 1976, which revealed a major separation between the deeper waters of the Java Sea basin and the shallow inshore waters. The main faunal transition appeared to be at 25-30 m. Furthermore, it was possible to identify further distinctions, as for example Group 1, characterized by the presence of sponges and the scarcity of Leiognathidae as compared to the other groups where this family dominates.

It was not possible, due to scarcity of comparable stations, to study seasonal changes in community structure; they are presumed to exist, given the large observed changes in biomass.

The data collected through the *Mutiara 4* resources surveys, and now stored in an easily accessible database (Torres et al., this vol.) are of great value as they constitute the evidence of the status of the fisheries resources in the Java Sea 20 years ago. This type of information is not available in many tropical regions, where important environmental, mainly fisheries-induced, changes have taken place in the last few decades.

It is, however, important to recognize that the quality of these data limits the range of further analyses that are possible (i.e., biodiversity and community dynamics). Particularly critical is the identification of the catches. Although this improved during the survey period, the use of large categories such as "other fish" or "trashfish" gives the opportunity to the data collector to easily "dump" into a large category any species that is difficult to identify. Furthermore, this process leads to inconsistencies between different parts of a survey, as it largely depends on the collector's personal capabilities.

Many trawl surveys have suffered, and still do because of similar shortcomings. The justification usually given is that the main aim is to monitor the important commercial groups. This is obviously valid but it might be argued that given the high cost of the surveys, and the relatively small increase in cost to carry out a full identification of the catches, identification to species level should be standard in any type of survey. Furthermore, the rapid change in the environment from the one side and the possibility to easily store and access the information derived from surveys from the other, would make surveys with properly identified catches of much greater value. Through this contribution, the authors recommend that the community of marine scientists ensures, as far as possible, a thorough identification in any type of marine resources surveys. This will give the surveys a more general value in addition to fulfilling their immediate objectives. They will become a piece of history.

Acknowledgements

The authors wish to acknowledge Daniel Pauly's effort to increase our understanding of tropical fish ecology by stimulating the maximum utilization of information from existing data sets. Without doubt, he has been the *primus motor* in the realization of this project.

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Structure and Dynamics of the Demersal Resources of the Java Sea, 1975-1979

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Abstract

The demersal fisheries of the Java Sea and their resource base were studied using commercial catch and effort data and the results of scientific surveys. Surplus production models were applied to the catch and effort data. Model results indicate that effort levels were near optimal in the late 1970s, except for the southeastern coast of Sumatra and northern coast of Java where, due to nearshore shrimp trawling, fishing effort was well above that required to generate maximum sustainable yield.

A principal component analysis demonstrated that 76% and 65% of the changes among years of demersal resource abundance was explained by the first two principal components for the lightly exploited areas and the highly exploited areas, respectively. Among areas representing different levels of fishing pressure, no difference was detected in the number of taxonomic groups at each trophic level significantly contributing to the first two principal components. Overall, throughout the 1970s, no major changes occurred in the trophic structure of the demersal resources in the various areas of the Java Sea.

Abstrak

Sumberdaya demersal dan perikanannya di Laut Jawa dianalisis melalui data statistik perikanan dan data dari kapal penelitian. Model surplus produksi diaplikasikan terhadap hasil tangkapan dan upayanya. Hasil analisis menunjukkan bahwa tingkat upaya mendekati optimal pada tahun 1970-an, kecuali untuk daerah pantai tenggara Sumatra dan pantai utara Jawa, dimana karena banyaknya trawl udang maka tingkat penangkapan sudah melebihi titik batas untuk mendapatkan hasil tangkapan yang maksimum.

Analisis "komponen pokok" terhadap hasil tangkapan menunjukkan bahwa masing-masing perubahan antar tahun (76% dan 65%) dari kelimpahan sumberdaya demersal dapat dijelaskan oleh dua komponen pokok awal untuk daerah yang tekanan penangkapannya kurang dan yang tingkat penangkapanya sudah jenuh. Daerah-daerah dengan keragaman tingkat penangkapan yang berbeda tidak menunjukkan adanya perbedaan dalam grup taksonomi pada setiap jenjang rantai makanan yang berarti mendukung pada dua komponen pokok awal. Secara keseluruhan, selama tahun 1970-an, tidak terlihat adanya perubahan dalam struktur rantai makanan untuk sumberdaya demersal di berbagai daerah Laut Jawa.

Introduction

The Java Sea is the most southern part of the Sunda Shelf, where the latter connects the western part of Indonesia with the Asian mainland. The Java Sea itself is bordered by the southern part of Sumatra, Kalimantan and by the northern coast of Java (Fig. 1).

The Java Sea resources make an important contribution to Indonesian fisheries, being the main supplier of fish protein for the population of Java, where most of the Indonesian population lives. Moreover, the large number of fishers based on the shore of the Java Sea - more than 120,000 in 1979, plus 90,000 part-timers (DGF 1981) - reflects the importance of its fishing grounds for the livelihood of many people.

Development of the Indonesian fisheries started in the early 1970s when the first five-year plan was launched (Zachman 1973). At the start of the 1970s, estimates of potential yield were not available, except for extrapolations from the Gulf of Thailand. Thus, Tiews (1966) estimated annual yields of demersal fish to be 3.6 $t \cdot km^{-2}$ for the Sunda Shelf, including the Java Sea, while Gulland (1971) presented a more

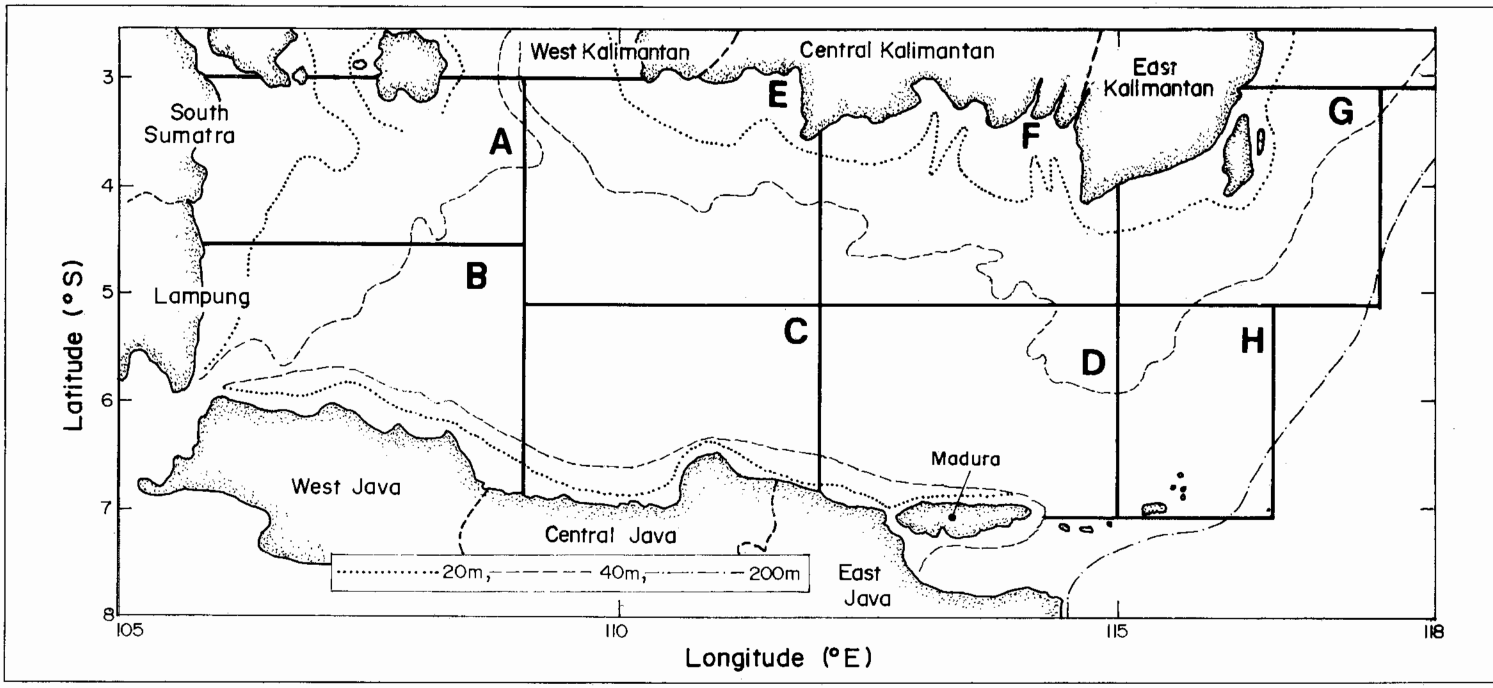

Fig. 1. Map of the Java Sea showing its bathymetry, and defining the (sub)areas used for data analysis and presentation of results, and roughly matching provincial borders.
[Gambar 1. Peta Laut Jawa yang menunjukkan pola batimetriknya dan pembagian daerah (sub-daerah) yang digunakan dalam analisis, yang mana batasannya kurang lebih mendekati batas propinsi.]

conservative estimate of 1.5-2.5 t·km^{-2}. However, the first systematic trawl surveys in the Java Sea indicated standing stocks at 2.15 and 3.24 t·km^{-2} (Saeger et al. 1976; Pauly et al., this vol.). Assuming annual yield to be about half the standing stock size leads to potential yields even lower than suggested by J. Gulland, which points both at the usefulness of surveys and the danger of extrapolating.

The rapid expansion of the Java Sea fisheries during the 1970s was driven by the deployment of bottom trawlers and purse seiners (Martosubroto 1978). However, other fishing gears also increased substantially. During this period, total catch from the Java Sea more than doubled, from 140,000 t in 1970 to 332,000 t in 1979. The demersal catch, however, increased at a slightly slower rate, from about 60,000 t to 138,000 t in 1979, or an increase of 130%.

The operation of the demersal trawlers was largely limited to waters shallower than 40 m, and most fishing effort was applied along the northern coast of Java, where the small-scale fishers were (and still are) concentrated. Latent conflicts between the small-scale fisheries and trawl operators were inevitable.

One way to address these was through studies of the fisheries and their resource base, aimed at identifying a level of demersal trawl effort compatible with the overall productivity of the resource, and the need to sustain existing small-scale fisheries (Sujastani 1978).

Some management measures for the fisheries in the Java Sea were introduced in the early 1970s, before these studies were conducted. These measures included boat size regulations (Zachman 1973), zoning of fishing activities, and mesh size limits (SCSP 1979). They did not achieve their aims, however. This led, in conjunction with the breaking out of open conflicts between small-scale fishers and trawl operators, to the banning of trawl fishing in the waters surrounding Java and Sumatra in 1980 and 1981, respectively (Sardjono 1980).

Trawl survey data in the Java Sea became available from 1974 onwards and were collected continuously to the end of the 1970s (Martosubroto and Pauly 1976; Saeger et al. 1976; Losse and Dwiponggo 1977; Dwiponggo and Badrudin 1980; Bianchi et al., this vol., Pauly et al., this vol., and see the database described in Torres et al., this vol.). The present study evaluates the status of demersal resources of the Java Sea in the 1970s, based on these survey data, and on commercial catch and effort data for the same period, collected by staff of the Indonesian Directorate General of Fisheries (DGF).

Materials and Methods

Study Area

The Java Sea has an almost rectangular shape with a long axis of approximately 890 km parallel to Java and a short axis of 390 km. Its bottom gently slopes from the shoreline to the center and from west to east; the western part has an average depth of about 20 m while the eastern part is about 60 m deep (Fig. 1).

The bottom sediment of the Java Sea consists mostly of mud. A map compiled by Emery (1969) revealed that 69% of the total area consists of thick gray mud, 17% of mud and sand, and 12% of sand, with the remaining 2% consisting of rocks and corals mainly near Bangka and Biliton Islands, in the vicinity of the Sunda Strait and, in the east, along the edge of the continental shelf (Fig. 2).

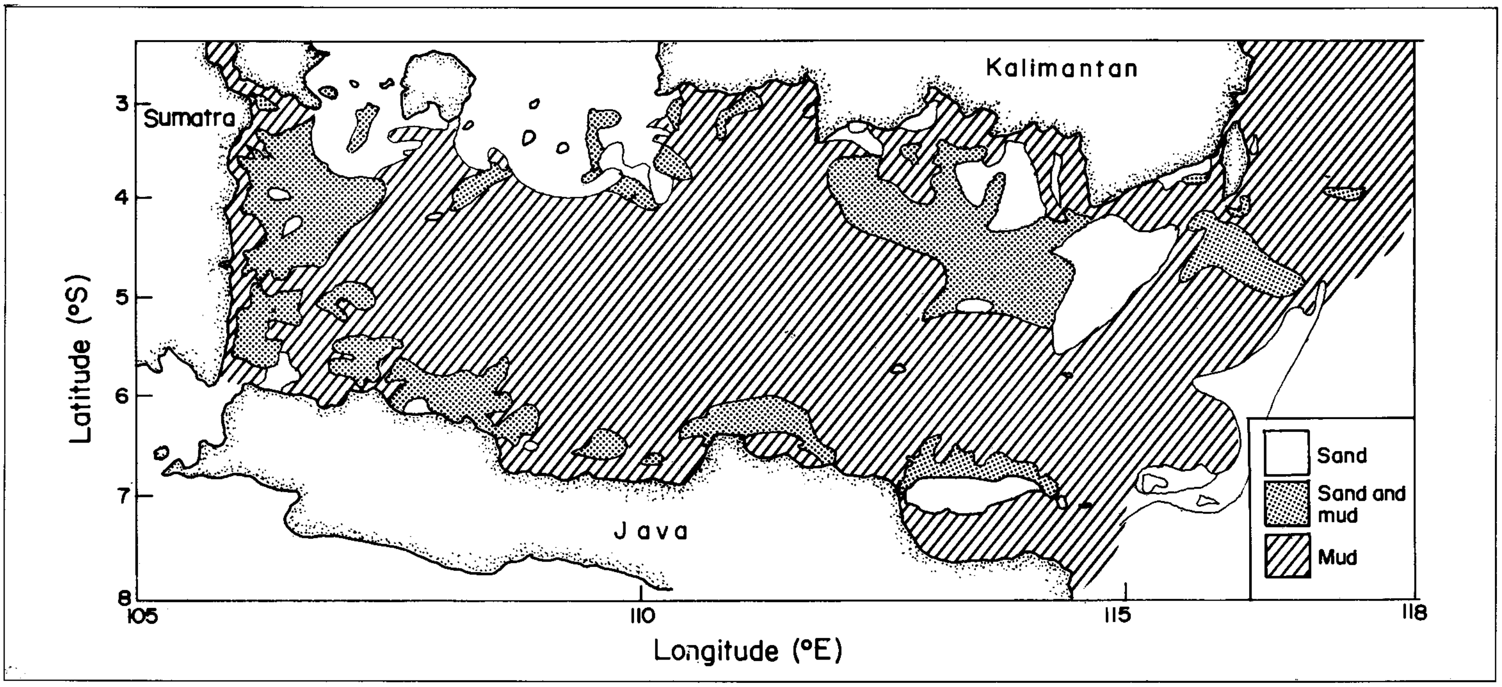

Fig. 2. Bottom types of the Java Sea (after Emery 1969).
[Gambar 2. Tipe dasar perairan Laut Jawa [(menurut Emery 1969)].

The hydrography of the Java Sea has been studied since the beginning of the century by Dutch scientists (Berlage 1927; van Riehl 1932) and from the 1950s by Indonesian scientists (Soeriatmadja 1956; Sjarif 1959). A comprehensive description of the Java Sea was presented by Wyrtki (1961) as part of his extensive study of Southeast Asian waters.

These studies demonstrated a strong impact of the west monsoon which extends from December to February, and of the east monsoon which lasts from June to August. The rest of the year forms transition periods between the two regimes. During the west monsoon, the wind generates eastward-moving surface currents that bring low salinity water of the South China Sea into the Java Sea. The heavy rains during the west monsoon increase the runoff from rivers in Sumatra, Kalimantan and Java and further depresses the salinity in the Java Sea. It is not uncommon, in its eastern part, for the 3.0% isohaline to be pushed far into the open ocean. During the east monsoon, these conditions are reversed; westward winds generate surface currents that bring high salinity water from the Makassar Strait and the Flores Sea into the Java Sea and pushes its low salinity water into the southern South China Sea. The high salinity water masses reach their maximal westward penetration in September (see Fig. 2 in Venema, this vol.).

The distribution of primary productivity also varies with the monsoons (Doty et al. 1963). During the west monsoon, the average primary productivity of the surface layer increases not only toward the coast but also from west to east. The 1 mgC·hour^{-1}·m^{-3} isoline runs approximately in the mid-part of the Java Sea, dividing the area into two parts (Fig. 3A). During

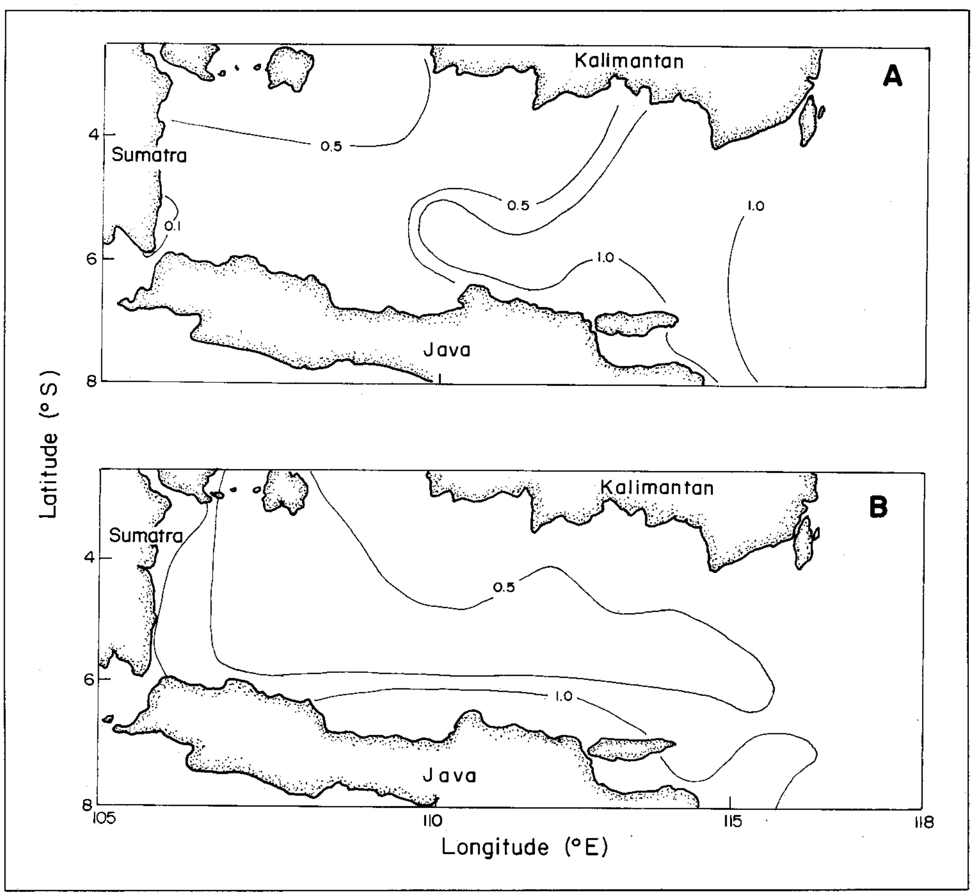

Fig. 3. Surface primary productivity in the Java Sea, in mgC·hour^{-1}·m^{-3} (after Birowo et al. 1975): A, during the west monsoon; B, during the east monsoon.
[Gambar 3. Produktivitas primer Laut Jawa dalam mgC·jam^{-1}·m^{-3} (menurut Birowo et al. 1975): A, selama musim barat; B, selama musim timur.]

the east monsoon, this isoline is pushed westward and it eventually lies parallel to the northern coast of Java (Fig. 3B).

Statistical (Catch and Effort) Data

Commercial fishing operations exploiting demersal stocks are normally limited to depth ranges shallower than 40 m, whereas traditional small-scale gears operate inside the 20-m depth contour. For these reasons, the surplus production and principal component analyses presented below were applied to areas within the depth of 40 m. To analyze the trawl survey data, the Java Sea was arbitrarily divided into eight areas: five off the southeast coast of Sumatra and north coast of Java (A, B, C, D and H), and three off the south coast of Kalimantan (E, F, G; see Fig. 1). The data from areas G and H were not considered because they were surveyed on two occasions only. The limits of these areas roughly correspond to the provincial borders (Fig. 1), defining how catch and effort statistics were aggregated.

The publication of Indonesian fisheries statistics by DGF began only in 1972, and those published prior to 1975 were of limited use for stock assessment purposes, mainly because the information was overaggregated: the landing statistics were broken down by province without further partition within each province. Thus, those interested in assessing the stocks of, say Central Java Province, with fishing grounds in the Java Sea (a part of the Pacific Ocean), and in the Indian Ocean, were forced to visit the Fisheries Services at the *Kabupaten* (i.e., county) level to obtain data pertinent to the one, or the other ocean (see e.g., Martosubroto 1978 and Sujastani 1978). Moreover, although the statistics from the mid- to late 1970s presented more detailed information, the species composition of the catch of various gears still could not be derived from the data; hence the adjustments presented below.

Fish caught in Java Sea are landed in three provinces (West Java, Central Java and East Java) and one municipality (Jakarta) along the north coast of Java, two provinces in southeast Sumatra (Lampung and South Sumatra) and three provinces along the southern coast of Kalimantan (West Kalimantan, Central Kalimantan and South Kalimantan) (Fig. 1). As appropriate statistics were not available at the *Kabupaten* level and provincial statistics often lump catches from different areas of the Java Sea, a number of assumptions were made to disaggregate the available data:

1. the catches and number of fishers along the coast of East Java Province facing the Java Sea represent 45% of these values for the whole of Java (the Madura Strait is excluded in the analysis as it has been closed to trawling since 1975);
2. the fisheries statistics for that part of the coast of South Sumatra Province facing the Java Sea account for 35% of the total landings of that province;
3. the fisheries statistics for that part of the coast of West Kalimantan Province facing the Java Sea represent 5% of the statistics of the whole province; and
4. the fisheries statistics for that part of the coast of South Kalimantan Province facing the Java Sea account for 75% of the statistics of the whole province.

These assumptions are based on relative coastline length within each provincial unit. Obviously, any drastic changes in the deployment of effort within these provinces could invalidate the assumptions for a particular area. Over the 1975 to 1979 period, however, such drastic changes did not occur. Since 1980, there have been major changes, most notably the above mentioned ban on trawling.

Trawl Survey Data

Pauly et al. (this vol.) and Bianchi et al. (this vol.) described the trawl survey conducted from 1974 to 1979 in the Java Sea, which generated the data analyzed here.

The *Mutiara 4* and "Thailand trawls" were used for all of these surveys (see Pauly et al., this vol. for descriptions). The rigging of the net was slightly changed in June 1976 (Table 1), prior to gathering the data underlying Fig. 4; however, as the modifications were minor, catch rates can be assumed not to have been altered.

Fig. 5 illustrates the variability of the trawl survey data used here. As might be seen, there is a linear correlation between the means and the standard deviation of the catch rates for the demersal groups, which suggested that a log-transformation of the data might be appropriate for at least some of the analyses (Steel and Torrie 1960). Retransformed means (Fig. 6) were thus obtained following Bliss (1967) using

$$y = \exp(x + s^2/2) - 1 \quad \text{...1)}$$

where

y = the retransformed catch per haul;

Table 1. Specification of trawl net used during the *Mutiara 4* survey.
[Tabel 1. Spesifikasi jaring trawl Mutiara 4 *yang digunakan dalam survei.]*

Trawl characteristics	Prior to June 1976	Since June 1976
Circumference (lower bosom)	147 meshes, 160 mm stretched	147 meshes, 160 mm stretched
Cod-end mesh	40 mm	40 mm
Headline length	15.0 + 3.0 + 15.8 = 33.8 m	16.85 + 3.0 + 16.85 = 36.7 m
Footrope length	20.1 + 2.0 + 20.1 = 42.2 m	21.25 + 2.0 + 21.25 = 44.5 m
Floats on headline	27-30	21
Iron rings on footrope	24	20
Chains and weights	1 chain (8 kg) on bosom, 15 kg chain on wing ends, 8 kg weight on legs	1 chain (8 kg) on bosom, 15 kg chain on wing ends
Otterboard dimensions	2.0 x 1.0 x 0.05 m, one float 50 x 20 cm on each board (92 kg each)	2.0 x 1.0 x 0.05 (92 kg each)
Bridles and legs	50 m bridles + 25 m legs	50 m bridles + 18 m legs

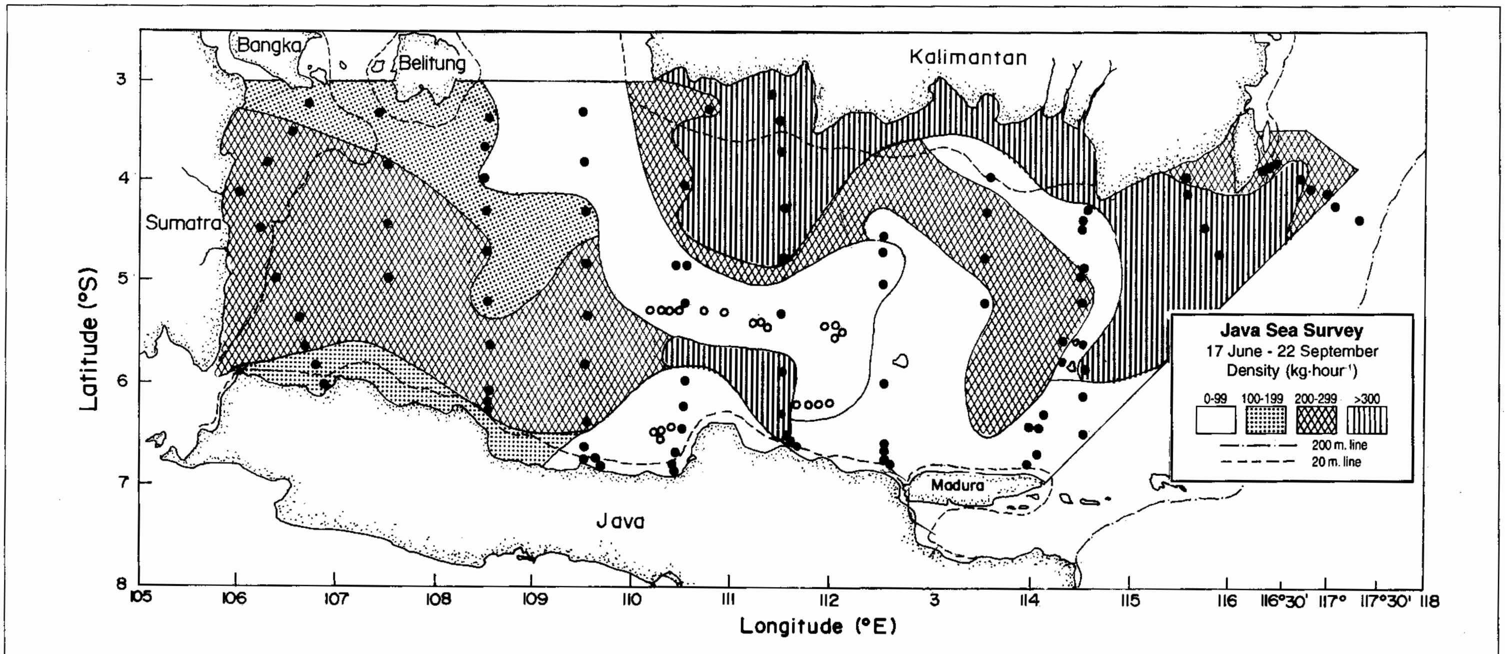

Fig. 4. Trawl survey of *R/V Mutiara 4* in the Java Sea, from 17 June to 22 September 1976, illustrative of other surveys considered on this contribution. Each dot represents a valid 1-hour haul (see Pauly et al., this vol., for details on the survey methodology and assumptions).
[Gambar 4. Survei trawl kapal penelitian Mutiara 4 *di Laut Jawa, dari 17 Juni hingga 22 September 1976, digambarkan terhadap survey yang lain. Tiap bulatan menggambarkan 1 jam tarikan (lihat Pauly et al., dalam buku ini, dalam hal metodologi survei dan asumsinya.)*

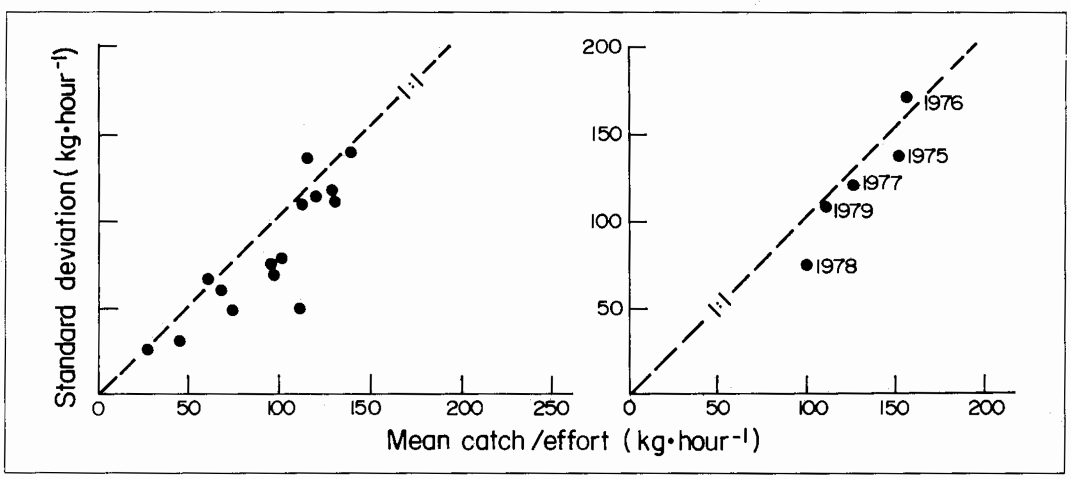

Fig. 5. Relation between the magnitude and the variability of demersal trawl survey catch rates. Left: survey cruises of 1979 in areas A and B (southeastern Sumatra and north Java coast). Right: mean annual C/f and their standard deviation in areas C and D (north coast of Central and East Java) for the years 1975 - 1979.
[Gambar 5. Hubungan antara hasil tangkapan per upaya dan variasinya dari trawl survei ikan-ikan demersal. Kiri: pelayaran survei tahun 1979 di daerah A dan B (bagian tenggara Sumatra dan pantai utara Jawa). Kanan: rata-rata hasil tangkapan per upaya (C/f) dan simpangan bakunya di daerah C dan D (pantai utara Jawa Tengah dan Timur) dalam tahun 1975-1979.]

x = the original mean catch per haul; and
s^2 = the variance of the log-transformed data.

Further details on the catch/effort data used here may be found in the survey reports, i.e., Martosubroto and Pauly (1976) and Saeger et al. (1976) for the first phase (November 1974 to July 1976; see also Pauly et al., this vol.) and Losse and Dwiponggo (1977) and Dwiponggo and Badrudin (1980) for the second phase (August 1975 to 1979; see also Bianchi et al., this vol.)

Principal Component Analysis

Principal component analysis (PCA) as used here involves the analysis of a multidimensional cloud of sample points, as defined by the abundances of the species they contain. Each species represents an axis (dimension), and the position of each sample point is defined by as many species (axes, dimensions) as the set of samples included. A set of samples with 100 species, for example, would be defined as a cloud of points in a space of 100 dimensions. The relationships among the points can be studied by combining sets of axes (species) into a reduced set of principal axes, each of which is made up of a simple linear combination of species. The axes are extracted in decreasing order of their eigenvalues, which represent successively smaller amounts of the variation of the cloud in the hyperspace. Often, 80% or more of the total variation of the cloud can be represented in the first few principal axes. This means that the original data cloud can be represented with very little distortion by replotting the sample points based on their coordinates on a few principal axes. The version used in this study employed an eigenanalysis of the correlation matrix, thus yielding axes based on a data cloud which has been centered and standardized with respect to the principal axes. These principal axes summarize the variations

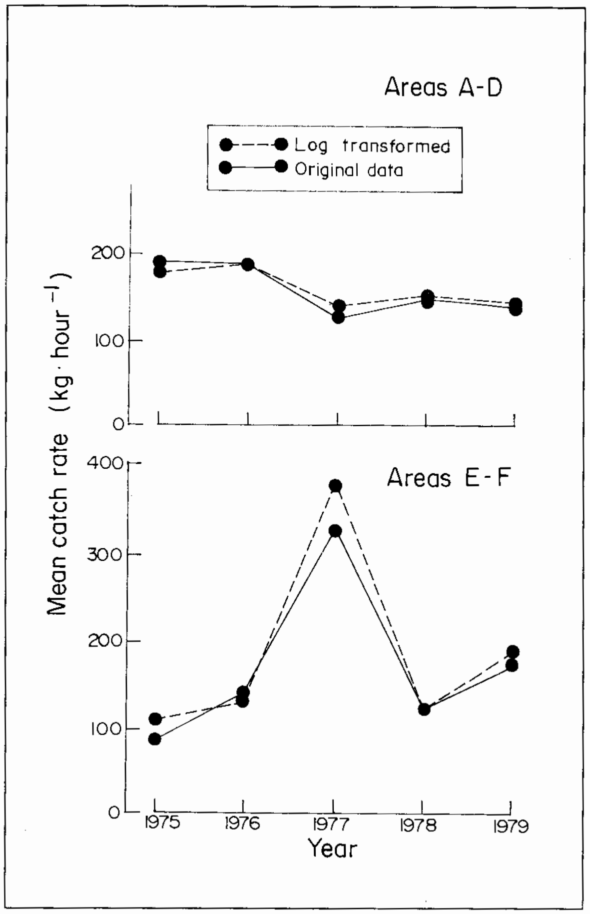

Fig. 6. Mean trawl survey catch rates in areas A-D (above) and E-F (below), illustrating small differences between original data (i.e., arithmetic means; solid lines) and log-transformed data (i.e., geometric means; dotted lines), thus justifying the use of the log-transformation to stabilize variances.
[Gambar 6. Rata-rata hasil tangkapan per upaya survei trawl di daerah A - D (atas) dan E - F (bawah), menggambarkan perbedaan kecil antara data asli [rata-rata, garis penuh] dan data yang ditransformasikan ke dalam logaritma (rata-rata geometrik, garis putus-putus), yang menunjukkan perlunya transformasi untuk menstabilkan keragaman.]

of sets of species, which can be contrasted against variations in environmental factors or time to yield insights into casual relationships (Sokal and Rohlf 1969; Sneath and Sokal 1973; Pielou 1977).

Surplus-Production Modelling

The application of the surplus production model (Schaefer 1954, 1957; Ricker 1975) to data from a fishery implies that the dynamics of the population exploited by that fishery follows a logistic growth trajectory.

Although this assumption has not been explicitly demonstrated to apply to multispecies tropical stocks, experience has shown that the fit of surplus-production model to multispecies assemblages is generally better than that of the individual species, as indicated by the higher correlation in the regression of catch per unit of effort with effort (FAO 1978; Pauly 1979). Two likely explanations for this have been offered by Pope (1979), i.e.:

1. treating the whole species as a single unit implicitly accounts for the biological interactions between the component species; and/or
2. the fishers react to local decline of their catch/effort by shifting their effort to other components of the multispecies resources, and thus cause an evening out of the catch/effort *vs.* effort relationship.

However good the fit of the surplus-production model to the multispecies situation may be, the main criticism remains, however, that the model does not explicitly incorporate interaction between the different component species of stocks (Pauly 1979).

In view of these drawbacks, Pope (1979) extended Schaefer's surplus-production model to explicitly account for biological and technological interactions. In Pope's reformulation, biological interactions are incorporated through either predator-prey or competitive relationships, while technological interactions are included through fixed ratios of the fishing mortalities, affecting the different component species of the multispecies stock.

The most important insights resulting from Pope's work are:

1. the apparent maximum sustainable yield (MSY) that can be extracted from a multispecies assemblage using a gear with a fixed set of catchabilities (e.g., a trawl) will almost invariably be lower than the theoretical MSY that may be obtained from the assemblage as a whole;
2. if the species in the assemblage are linked mainly through competitive relationships, then the stronger the competition, the smaller will the overall MSY of the assemblage be; and
3. if the species in the assemblage are linked mainly through predator-prey relationships, then the overall MSY that can be extracted from the assemblage will be higher than if the species are mainly competing with each other.

Conclusion (3) certainly makes sense: higher exploitation of predators should lead to an increase in prey population (May et al. 1979).

While a useful heuristic tool, Pope's multispecies extension of the surplus-production model cannot be used for practical assessments, due to an excessive number of parameters (x), which is a quadratic function of the number of interacting species (n), i.e.,

$$x = (cn + 1)^2 - 1 \qquad \textbf{...1)}$$

However, when investigating the demersal stocks of the Gulf of Thailand, Pope (1979) noticed that while the majority of species declined under exploitation, the ratio of their relative abundances remained roughly constant. This led to his suggestion that simple surplus-production models treating an entire multispecies assemblage as if it were a single species may be appropriate, and would lead to an MSY estimate not very different from those that would have been obtained, had an explicitly multispecies model been used.

This provides the justification for the application, in this study, of a simple Schaefer-type surplus-production model to the multispecies assemblages of the Java Sea, performed by plotting catch per effort (C/f) against effort (f) *viz.*

$$C/f = a + bf \qquad \text{...2)}$$

then multiplying both sides by f to obtain a (parabolic) surplus-production curve *viz.*

$$C = af + bf^2 \qquad \text{...3)}$$

whose maximum indicates MSY and optimum effort (f_{opt}).

To evaluate the sensitivity of the results to the quality of the input data, three different measures of C/f were used (Index 1, 2 and 3, defined in the legends of Figs. 13 and 14).

On the other hand, in view of the limited number of available data points (=years with catch and effort data), I have abstained from applying Gulland's approach for simulating equilibrium (i.e., plotting catch/effort of one year against the mean effort for that year and one or several preceding years; Gulland 1961). This should have resulted in an overestimation of MSY and optimum effort (Pauly 1984, 1987).

Results and Discussion

Fisheries of the Java Sea

NORTH COAST OF JAVA

Java is the most developed area in Indonesia and, at the same time, one of the most densely populated areas in the world. It is therefore not surprising that the island shows also the highest concentration of fulltime fishers. Also, the infrastructure (landing and auction sites, wet markets, roads) of the fishery industry on the north coast of Java is more developed than in other areas of Indonesia. As a result, the northern coast of Java accounted, in 1979, for 71.4% of the total catch from the Java Sea. However, most of this consisted of pelagic fish since 41.3% was caught by seines, 21.4% by gillnets, 15.7% by liftnets and other gears, and only 21.6% by trawlers.

Information on the number of fishers for each type of fishing gear is not available. However, based on the total number of trawlers and purse seiners operating based along the north coast of Java, and on the average number of crew on trawlers (8) and purse seiners (28) (Baum1978; Budihardjo 1978), the number of fishers engaged in these fisheries could be estimated as approximately 24,600 in 1979, or about 25% of the total number of fishers in the area. The majority of the fishers (75%) were thus engaged in small-scale or artisanal fisheries, and their productivity (1.25 t·fisher^{-1}·year^{-1}) was much lower than that of the crew of purse seiners and trawlers (4.55 t·fisher^{-1}·year^{-1}). Consequently, the number of crew on trawlers and purse seiners increased from 14,000 in 1976 to 25,000 in 1979, while the number of traditional fishers dropped in the same period from 84,000 to 75,000, many of them transferring from the artisanal to the industrial subsector.

SOUTHEAST COAST OF SUMATRA

The fisheries on the southeast coast of Sumatra were dominated in the 1970s by liftnets and gillnets which in 1979 contributed 53% and 19%, respectively, of fisheries catches, while trawlers contributed only 3%.

The total number of fulltime fishers in 1979 was 9,000; of these, about 3% worked as crew on trawlers. The rate of increase of the number of fishers (11% year^{-1}) in this area was higher than along the northern Java Sea coast and may have been related to population transmigration from Java.

Table 2. Annual demersal catches (t) by gear and year from the North Java and Southeast Sumatra coasts.
[Tabel 2. Hasil tangkapan tahunan ikan-ikan demersal (t) berdasarkan jenis alat dan tahun untuk pantai utara Jawa dan Sumatra bagian tenggara.]

Type of gear	Year 1975	1976	1977	1978	1979
Trawl	30,789	40,323	47,799	49,118	53,960
Dogol [a]	3,937	10,099	8,521	10,045	9,357
Beach seine	12,624	4,640	2,702	3,547	5,280
Bottom gillnet	1,631	13,155	12,023	12,538	14,566
Liftnet	20,070	26,190	34,325	43,370	40,102
Longline	5,051	1,794	1,565	1,339	1,470
Handline	4,041	10,143	10,143	10,839	11,741
Stow net	585	667	125	200	178
Trap	1,138	8,927	7,232	7,550	4,764
Total	79,866	115,938	124,435	138,546	141,418
Total demersal catches	69,106	90,252	95,279	103,088	111,703

[a] *Modified Danish seine.*

Table 3. Annual demersal catches by gear and year from the coast of Southern Kalimantan.
[Tabel 3. Hasil tangkapan tahunan ikan-ikan demersal berdasarkan jenis alat dan tahun untuk pantai selatan Kalimantan.]

Type of gear	Year 1975	1976	1977	1978	1979
Trawl	576	1,016	641	899	1,100
Beach seine	2,411	2,748	2,604	1,803	2,451
Bottom gillnet	6	6	72	1,479	2,708
Liftnet	408	2,722	1,917	4,999	3,897
Bottom longline	320	240	679	1,618	1,836
Handline	30	2,032	350	747	513
Stow net	362	1,073	450	631	705
Traps	354	2,726	338	72	47
Total	4,467	12,563	7,051	12,248	13,257
Total demersal catches	15,401	19,572	15,780	22,718	26,321

Table 4. Structure of taxonomic principal components for the demersal resources in areas A-D (Southeast Sumatra and North Java Coast), ranked by their eigenvectors; groups with similar eigenvectors tend to co-occur.
[Tabel 4. Struktur komponen pokok berdasarkan pembagian taksonomi dari sumberdaya demersal di daerah A hingga D (Sumatra bagian tenggara dan pantai utara Jawa), diklasifikasi berdasarkan nilai eigenvector; grup dengan nilai eigenvector yang berdekatan cenderung untuk muncul bersama.]

Taxonomic group	PC-1 (40.1% of var.)		PC-2 (25.2% of var.)	
	Eigen-vector	Corre-lation[a]	Eigen-vector	Corre-lation[a]
Gerreidae	0.25	0.99**	-0.02	-0.06
Mullidae	0.24	0.95**	0.04	0.13
Carangidae	0.23	0.89**	-0.10	-0.32
Lutjanidae	0.22	0.85*	-0.13	-0.41
Sharks and rays	0.21	0.84*	0.11	0.35
Thenus orientalis	0.19	0.74	0.18	0.57
Nemipteridae	0.19	0.75	0.22	0.67
Serranidae	0.05	0.21	-0.04	-0.13
Squids	0.05	0.21	0.01	0.03
Priacanthus spp.	0.04	0.16	0.29	0.90**
Balistidae	0.03	0.10	0.25	0.79
Sphyraenidae	0.01	0.04	-0.26	-0.81*
Muraenesocidae	-0.03	-0.12	0.23	0.71
Pentapodidae	-0.05	-0.19	0.27	0.84*
Trichiuridae	-0.05	-0.20	-0.07	-0.22
Chirocentridae	-0.06	-0.22	0.05	0.15
Other food fish	-0.09	-0.35	-0.04	-0.13
Trash fish	-0.09	-0.36	-0.29	0.90**
Rachycentridae	-0.10	-0.39	-0.14	-0.44
Terapontidae	-0.11	-0.45	0.00	0.01
Synodontidae	-0.11	-0.43	0.21	0.64
Ariidae	-0.12	-0.45	0.25	0.76
Formio niger	-0.14	-0.53	-0.22	-0.67
Leiognathidae	-0.14	-0.56	0.02	0.05
Polynemidae	-0.15	-0.59	-0.04	-0.13
Engraulidae	-0.16	-0.64	0.16	0.51
Heterosomata	-0.16	-0.63	0.24	0.73
Pomadasyidae	-0.17	-0.66	0.23	0.71
Shrimps	-0.17	-0.65	0.19	0.60
Other invertebrates	-0.18	-0.71	-0.14	-0.44
Sciaenidae	-0.19	-0.75	0.12	0.36
Scombridae	-0.19	-0.73	-0.05	-0.16
Drepanidae	-0.20	-0.78	-0.09	-0.29
Stromateidae	-0.21	-0.83*	-0.15	-0.46
Clupeidae	-0.22	-0.89**	-0.09	-0.29
Crabs	-0.22	-0.88**	-0.13	-0.40
Cuttles	-0.23	-0.90**	0.00	0.00
Lactarius lactarius	-0.25	-0.98**	-0.01	-0.02

[a]* significant at $p < 0.10$; ** significant at $p < 0.05$.

Table 2 summarizes the available data on demersal catches for the north coast of Java and the southeast coast of Sumatra.

SOUTH COAST OF KALIMANTAN

In the 1970s, Kalimantan was far less developed than the two above discussed areas. Landing facilities were lacking and roads hardly existed. In 1979, the bulk of the fisheries catches (62%) originated from gillnets, followed by liftnets (13%).

In 1970, a joint venture company was established in Kotabaru to exploit the shrimp resources off the southern and eastern coasts of Kalimantan. This company started with 6 trawlers in 1970 and had 60 trawlers by 1975 (Naamin and Uktolseya 1976) and employed relatively high technology compared to the existing trawlers in this area. Because this company was only interested in shrimp, all other fish were thrown back to the sea, a practice otherwise very uncommon in Western Indonesia. Data on the quantity of fish thrown overboard are not available, although rough estimates could be made using the average ratio of 1:22 in weight of shrimp to fish. Since total shrimp landings of this company on the south coast of Kalimantan were 1,124 t in 1975 (Naamin and Uktolseya 1976), the by-catch dumped in that year could have reached 24,000 t, an amount similar to total fish landings in the same area. Whether the increase of fishing pressure on shrimp caused changes in the ratio of shrimp to by-catch is not known, as the studies reported on by Naamin and Uktolseya (1976) were discontinued.

The number of fulltime fishers along the coast of southern Kalimantan was estimated as about 11,000 in 1979.

Table 3 summarizes the available data on demersal catches from the coast of South Kalimantan.

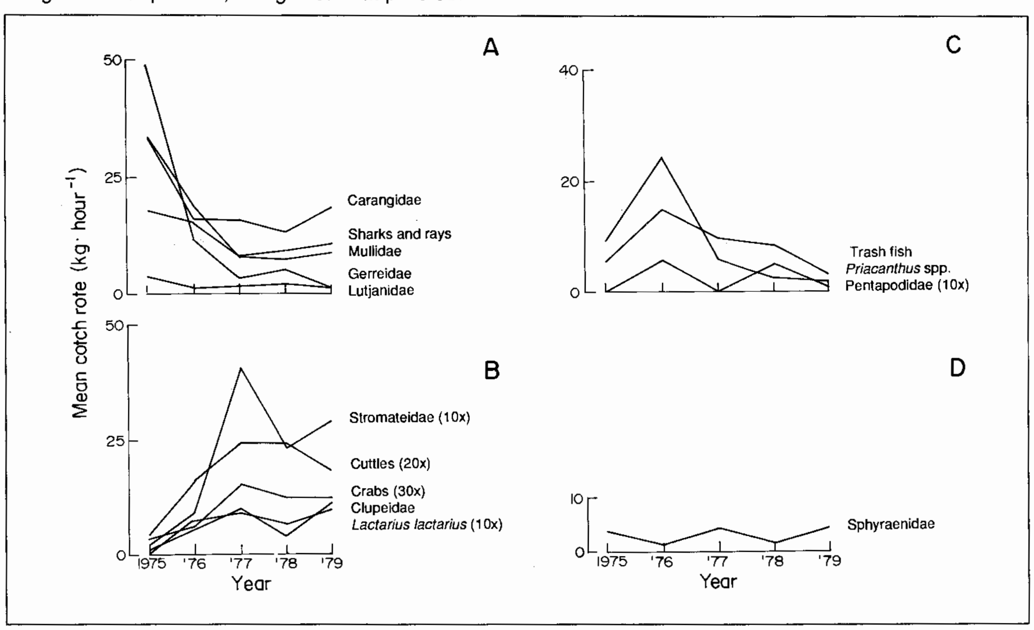

Fig. 7. Trend in abundance of some taxonomic groups of Areas A-D (Southeast Sumatra and North Java coast) showing high correlations with PC-1 and PC-2 (see also Table 4); A: positive correlations with PC-1; B: negative correlations with PC-1; C: positive correlations with PC-2; D: negative correlations with PC-2
[Gambar 7. Perubahan kelimpahan beberapa grup ikan [menurut taksonomi] di daerah A - D (tenggara Sumatra dan pantai utara Jawa) yang menunjukkan korelasi tinggi dengan PC-1 dan PC-2 [lihat Tabel 4); A: korelasi positif dengan PC-1; B: korelasi negatif dengan PC-1; C: korelasi positif dengan PC-2; D: korelasi negatif dengan PC-2.]

Table 5. Product moment correlation[a] of the first principal component for the demersal resources in individual areas of the Java Sea.
[Tabel 5. Korelasi product moment[a] dari komponen pokok awal dari sumberdaya demersal di setiap daerah (A hingga D) di Laut Jawa.]

Taxonomic group	A-D	A	B	C	D
Gerreidae	0.99**	-0.69	0.67	0.78	0.71
Mullidae	0.95**	-0.49	0.73	0.46	0.68
Carangidae	0.89**	-0.75	0.09	0.69	0.92**
Lutjanidae	0.85**	-0.64	0.81**	0.42	0.86**
Sharks and rays	0.84**	0.32	0.56	0.85**	0.78
Nemipteridae	0.75	0.35	0.79	0.78	-0.96**
Thenus orientalis	0.74	-0.13	0.77	0.17	-0.99**
Other invertebrates	0.71	0.58	-0.95**	0.54	0.44
Serranidae	0.21	-0.83	0.35	0.17	0.06
Squids	0.20	-0.75	-0.74	0.83**	0.78
Priacanthus spp.	0.16	-0.90**	-0.59	0.71	0.49
Balistidae	0.10	0.89**	0.55	0.51	-0.99**
Sphyraenidae	0.04	-0.66	-0.50	0.48	0.52
Muraenesocidae	-0.12	0.49	0.67	0.64	0.40
Pentapodidae	-0.19	-0.20	-0.87**	0.13	-0.94**
Trichiuridae	-0.20	0.85	0.04	-0.97**	0.41
Chirocentridae	-0.22	0.74	0.13	0.58	0.39
Trash fish	-0.36	0.19	-0.66	0.89**	0.42
Other food fish	-0.36	-0.36	0.71	0.36	0.99**
Rachycentridae	-0.39	0.64	-0.45	0.89**	0.33
Synodontidae	-0.43	0.70	0.05	0.79	0.81**
Terapontidae	-0.45	0.94**	0.28	-0.56	-0.98**
Ariidae	-0.45	0.23	0.17	-0.93**	0.66
Formio niger	-0.53	0.69	-0.97**	-0.54	0.33
Leiognathidae	-0.56	0.65	-0.52	-0.81**	0.90**
Polynemidae	-0.59	0.82	-0.17	0.15	0.99**
Heterosomata	-0.63	0.47	0.36	0.89**	-0.92**
Engraulidae	-0.64	0.80	0.56	-0.68	0.88**
Shrimps	-0.65	0.93**	-0.46	-0.55	-0.99**
Pomadasyidae	-0.66	0.99**	0.17	0.43	0.83**
Scombridae	-0.73	0.43	-0.68	0.33	0.61
Sciaenidae	-0.75	0.74	0.51	0.48	0.71
Drepanidae	-0.78	-0.69	0.62	0.34	0.53
Stromateidae	-0.83**	0.99**	-0.48	-0.19	0.70
Clupeidae	-0.89	0.90**	-0.64	0.23	0.98**
Crabs	-0.89**	0.63**	-0.71	-0.96**	0.72
Cuttles	-0.90**	0.93**	-0.44	0.75	0.85**
Lactarius lactarius	-0.98**	-0.69	0.22	0.90**	0.79
Years included	1976-79	1975-79	1975-79	1976-79	1975-79
Variance explained (%)	47.4	33.0	40.9	57.3	40.1

[a] ** significant at $p < 0.05$.

Principal Component and Surplus-production Analyses

NORTH COAST OF JAVA/SOUTHEASTERN SUMATRA

Based on the correlation matrix of taxonomic group abundances during the five-year period from 1975 to 1979, the PCA indicated that 65.5% of the total variances of demersal resources abundance can be explained by the first two principal components (Table 4). The high positive values for the coefficients of the sharks and rays, Carangidae, Lutjanidae and Mullidae in the first principal component demonstrate their important contribution to the total variance of demersal abundance (Fig. 7A). The high negative values for Clupeidae, *Lactarius lactarius*, Stromateidae, cuttlefish and crabs reflect their increasing trends during the study period (Fig. 7B). However, they cannot compensate for the decline of the major groups, the overall result being a weak declining trend for the demersal assemblage as a whole.

The second principal component indicates the relative importance of Pentapodidae, Priacanthidae and "trash fish" (Fig. 7C). Again, the declining trend of these groups explains the variation of the total group in the second principal component, there being no strong compensation by other groups (Fig. 7D).

An analysis of the principal components in the individual areas (Table 5) shows that the various taxonomic groups contributed differently to the first principal component. However, it is not clear why there are more species groups explaining the total variation in Areas A, C and D than in area B. Still, the Gerreidae, Nemipteridae and Synodontidae show a declining trend in most areas. Biological data are not available which could be used to explain this phenomenon, but it may be that their juveniles are more susceptible to artisanal fishing gears that employ very small mesh sizes, such as liftnets and pushnets.

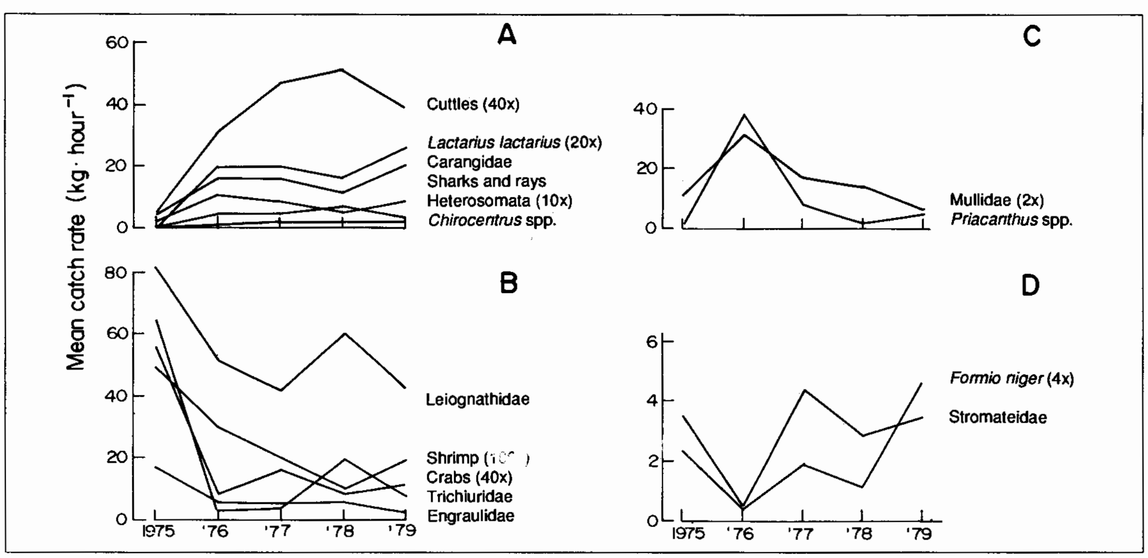

Fig. 8. Trends in abundance of some taxonomic groups of areas C and D (north coast of Central and East Java), showing high correlations with PC-1 and PC-2 (see also Table 6); A: positive correlations with PC-1; B: negative correlations with PC-1; C: positive correlations with PC-2; D: negative correlations with PC-2.

[Gambar 8. Perubahan kelimpahan beberapa grup ikan [menurut taksonomi] di daerah C dan D [pantai utara Jawa Tengah dan Timur] yang menunjukkan korelasi tinggi dengan PC-1 dan PC-2 [lihat Tabel 6]; A: korelasi positif dengan PC-1; B: korelasi negatif dengan PC-1; C: korelasi positif dengan PC-2; D: korelasi negatif dengan PC-2.]

Table 6. Structure of taxonomic principal components for the demersal resources in areas C-D (north coast of Central and East Java), ranked by their eigenvectors; groups with similar eigenvectors tend to co-occur.
[Tabel 6. Struktur komponen pokok berdasarkan pembagian taksonomi dari sumberdaya demersal di daerah C-D (pantai utara Jawa Tengah dan Timur) diklasifikasi berdasarkan nilai eigenvector; grup dengan nilai eigenvector yang berdekatan cenderung untuk muncul bersama.)]

Taxonomic group Muraenesocidae	PC-1 (43.0% of var.) Eigen-vector	Corre-lation[a]	PC-2 (31.5% of var.) Eigen-vector	Corre-lation[a]
Lactarius lactarius	0.23	0.94***	-0.06	-0.20
Heterosomata	0.22	0.87**	0.01	0.04
Cuttles	0.22	0.88***	-0.08	-0.27
Carangidae	0.22	0.89***	-0.05	-0.19
Chirocentridae	0.21	0.84**	-0.14	0.49
Sharks and rays	0.21	0.86**	0.07	0.24
Squids	0.18	0.74	0.08	0.27
Synodontidae	0.18	0.71	0.15	0.52
Gerreidae	0.18	0.74	0.17	0.60
Drepanidae	0.16	0.65	-0.12	-0.42
Other food fish	0.16	0.64	-0.14	-0.49
Pomadasyidae	0.15	0.60	-0.01	-0.04
Nemipteridae	0.15	0.60	0.21	0.74
Sphyraenidae	0.14	0.56	-0.21	-0.73
Other invertebrates	0.14	0.57	-0.18	-0.63
Rachycentridae	0.14	0.59	-0.19	-0.64
Lutjanidae	0.14	0.59	-0.06	-0.22
Trash fish	0.14	0.58	0.22	0.76
Scombridae	0.12	0.47	-0.09	-0.30
Sciaenidae	0.11	0.45	0.17	0.60
Clupeidae	0.11	0.45	-0.21	-0.73
Muraenesocidae	0.10	0.42	0.24	0.83**
Priacanthus spp.	0.10	0.41	0.24	0.84**
Balistidae	0.10	0.39	0.20	0.68
Pentapodidae	0.09	0.37	0.26	0.90***
Polynemidae	0.09	0.38	-0.17	-0.60
Mullidae	0.08	0.34	0.27	0.93***
Serranidae	0.05	0.20	-0.04	-0.13
Thenus orientalis	-0.00	-0.02	0.27	0.93***
Formio niger	-0.02	-0.09	-0.24	-0.83**
Stromateidae	-0.05	-0.22	-0.25	-0.86**
Ariidae	-0.15	-0.60	0.15	0.53
Terapontidae	-0.18	-0.75	-0.13	-0.43
Shrimps	-0.21	-0.83**	0.09	0.32
Leiognathidae	-0.23	-0.91***	0.07	0.26
Trichiuridae	-0.24	-0.99***	-0.01	-0.03
Engraulidae	-0.24	-0.95***	0.07	0.25
Crabs	-0.24	-0.97***	-0.01	-0.05

[a]** significant at $p < 0.05$; *** significant at $p < 0.01$.

Table 7. Structure of taxonomic principal components for the demersal resources in areas E-F (South Kalimantan), ranked by their eigenvector; groups with similar eigenvectors tend to co-occur.
[Tabel 7. Struktur komponen pokok berdasarkan pembagian taksonomi dari sumberdaya demersal di daerah E-F (pantai Kalimantan Selatan) diklasifikasi berdasarkan nilai eigenvector; grup dengan nilai eigenvector yang berdekatan cenderung untuk muncul bersama.)]

Taxonomic group	PC-1 (48.7% of var.) Eigen-vector	Corre-lation[a]	PC-2 (27.7% of var.) Eigen-vector	Corre-lation[a]
Sciaenidae	0.23	0.99**	0.01	0.03
Polynemidae	0.22	0.93**	-0.03	-0.10
Clupeidae	0.22	0.93**	-0.00	-0.01
Sharks and rays	0.21	0.89**	0.06	0.18
Leiognathidae	0.21	0.88**	0.13	0.43
Ariidae	0.21	0.90**	0.06	0.19
Pomadasyidae	0.20	0.88**	-0.09	-0.29
Lactarius lactarius	0.20	0.88**	0.14	0.46
Scombridae	0.20	0.85*	0.09	0.29
Drepanidae	0.20	0.86*	-0.12	-0.39
Muraenesocidae	0.19	0.81*	-0.16	-0.51
Heterosomata	0.19	0.82*	0.10	0.33
Shrimps	0.19	0.82*	0.02	0.05
Cuttles	0.19	0.82*	0.15	0.50
Theraponidae	0.18	0.77	0.07	0.24
Synodontidae	0.18	0.78	0.17	0.56
Other food fish	0.16	0.70	0.12	0.40
Formio niger	0.16	0.70	0.14	0.46
Trichiuridae	0.15	0.65	-0.16	-0.53
Crabs	0.15	0.64	0.01	0.04
Lutjanidae	0.15	0.63	-0.18	-0.58
Squids	0.12	0.51	0.22	0.70
Carangidae	0.10	0.44	0.27	0.87*
Serranidae	0.10	0.41	-0.06	-0.18
Sphyraenidae	0.08	0.33	0.20	0.65
Pentapodidae	0.07	0.29	0.12	0.39
Other invertebrates	0.05	0.22	-0.27	-0.89**
Mullidae	0.02	0.09	0.26	0.84*
Trash fish	-0.03	-0.11	0.26	0.85*
Rachycentridae	-0.05	-0.20	-0.22	-0.70
Gerreidae	-0.05	-0.21	0.29	0.94**
Nemipteridae	-0.07	-0.30	0.28	0.89**
Chirocentridae	-0.13	-0.54	0.25	0.81*
Stromateidae	-0.13	-0.55	0.10	0.33
Engraulidae	-0.18	-0.76	0.12	0.39
Balistidae	-0.19	-0.81*	0.16	0.51
Priacanthus spp.	-0.19	-0.82*	0.11	0.34
Thenus orientalis	-0.20	-0.89**	0.14	0.44

[a]* significant at $p < 0.10$; ** significant at $p < 0.05$.

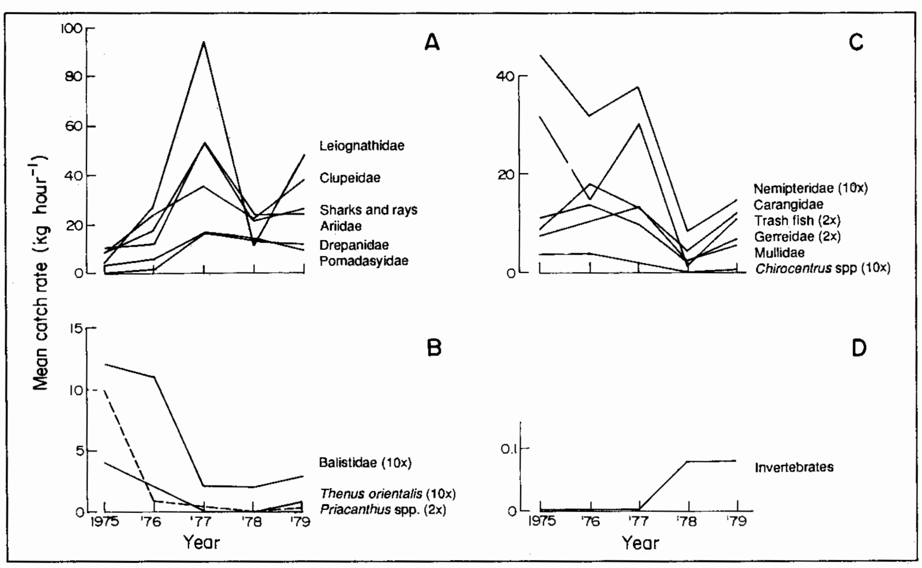

Fig. 9. Trends in abundance of some taxonomic groups in areas E and F (South Kalimantan) showing high correlations with PC-1 and PC-2 (see also Table 7); A: positive correlations with PC-1; B: negative correlations with PC-1; C: positive correlations with PC-2; D: negative correlations with PC-2.
[Gambar 9. Perubahan kelimpahan beberapa grup ikan (menurut taksonomi) di daerah E dan F (Kalimantan Selatan) yang menunjukkan korelasi tinggi dengan PC-1 dan PC-2 (lihat Tabel 7); A: korelasi positif dengan PC-1; B: korelasi negatif dengan PC-1; C: korelasi positif dengan PC-2; D: korelasi negatif dengan PC-2.]

The patterns that were identified here differed from those detected in the Gulf of Thailand: the consistent declining trend for nearly all individual taxonomic groups reported by Pope (1979) did not occur in the present analysis. This may be attributed to:

- fishing pressure on the demersal resources off the north coast of Java and southeast coast of Sumatra was not as heavy as in the Gulf of Thailand;
- fishing operations in the Gulf of Thailand were very much dominated by bottom trawling, whereas bottom trawl catches contribute only 35-38% of the total demersal catches of northern western Java and southeast Sumatra (see above).

North coast of Central and East Java

The PCA indicates that 74.5% of the total variance is explained by the first two principal components (Table 6). Sharks and rays, Carangidae, Chirocentridae, Heterosomata, *Lactarius lactarius* and cuttles make a significant positive contribution to the first principal component, i.e., increased their abundance (Fig. 8A). The Engraulidae, Leiognathidae, Trichiuridae, shrimp and crab make a significant negative contribution, i.e., exhibited declining trends (Fig 8B).

For the second principal component, declining abundance trends were observed for the Mullidae, Muraenesocidae, Pentapodidae, *Priacanthus* spp. and *Thenus orientalis* (Fig. 8C), while *Formio niger* and Stromateidae increased (Fig. 8D). However, here again, more important groups declined, and thus the entire demersal group declined as well.

Table 8. Assumed trophic levels (TL) and relative catch rate (in %) of taxonomic groups in areas A-H, in 1976, ranked by (1) trophic level and (2) % of catch rates within each trophic level.
[Tabel 8. Jenjang rantai makanan (TL) dan laju penangkapan relatif (dalam %) dari grup taksonomi di daerah A-H, tahun 1976, diklasifikasi berdasarkan (i) jenjang rantai makanan dan (ii) % laju penangkapan dalam setiap jenjang rantai makanan.]

Taxonomic group	TL	A	B	C	D	E	F
Rays	4	7.85	10.50	6.88	3.05	3.66	5.94
Ariidae	4	0.60	4.71	2.51	6.04	6.16	15.58
Priacanthus spp.	4	2.40	1.86	4.82	24.23	0.37	0.11
Pomadasyidae	4	0.87	4.71	1.80	0.62	3.45	2.91
Synodontidae	4	2.72	3.09	3.86	2.11	0.80	1.43
Sharks	4	4.20	0.39	0.06	0.49	3.40	0.97
Sciaenidae	4	0.82	0.88	1.74	3.18	1.17	1.31
Sphyraenidae	4	0.00	1.23	0.96	0.36	5.25	0.68
Trichyuridae	4	0.22	1.28	1.35	0.75	1.17	0.51
Pentapodidae	4	0.49	0.10	0.00	0.52	0.27	0.06
Chirocentridae	4	0.33	0.59	0.06	0.00	0.16	0.29
Serranidae	4	0.05	0.20	0.00	0.03	0.53	0.06
Muraenesocidae	4	0.00	0.39	0.06	0.19	0.21	0.00
Rachycentridae	4	0.00	0.00	0.06	0.00	0.05	0.29
Mullidae	3	5.56	16.18	7.65	6.72	9.34	10.45
Carangidae	3	6.10	9.56	6.05	7.89	6.42	4.57
Trash fish	3	10.35	4.90	4.89	7.96	4.67	2.74
Nemipteridae	3	5.40	3.87	2.12	2.34	2.02	1.37
Squids	3	1.42	1.18	5.40	1.07	2.44	2.74
Other food fish	3	0.54	1.18	0.19	0.49	1.27	0.63
Terapontidae	3	1.25	1.08	0.58	0.13	0.53	0.57
Balistidae	3	0.54	0.25	0.39	1.43	0.80	0.23
Stromateidae	3	0.93	0.69	0.45	0.10	0.27	0.68
Drepanidae	3	0.00	0.15	0.06	1.30	1.43	0.06
Cuttles	3	0.27	0.59	0.45	0.32	0.11	0.34
Lactarius lactarius	3	0.00	0.34	0.71	0.26	0.11	0.46
Heterosomata	3	0.33	0.54	0.39	0.13	0.11	0.17
Formio niger	3	0.27	0.10	0.13	0.03	0.27	0.46
Polynemidae	3	0.33	0.05	0.00	0.03	0.64	0.06
Thenus orientalis	3	0.33	0.20	0.19	0.16	0.16	0.00
Crabs	3	0.05	0.05	0.19	0.03	0.00	0.00
Leiognathidae	2	31.61	8.68	28.17	19.78	14.54	15.64
Clupeidae	2	5.72	1.42	1.99	1.82	14.07	11.53
Gerreidae	2	6.49	13.68	3.34	1.46	3.50	4.11
Scombridae	2	0.71	2.26	4.82	5.29	1.38	1.88
Engraulidae	2	0.60	1.62	6.50	0.32	3.08	3.31
Lutjanidae	2	0.05	1.28	0.19	0.49	4.46	4.91
Shrimps	2	0.38	0.29	0.19	0.06	0.74	0.29
Other invertebrates	2	0.11	0.00	0.13	0.00	0.00	0.06
Total catch/effort ($kg \cdot hour^{-1}$)	(2.88)[a]	184	204	156	308	188	175

[a]Overall mean weighted by the mean C/f over all areas.

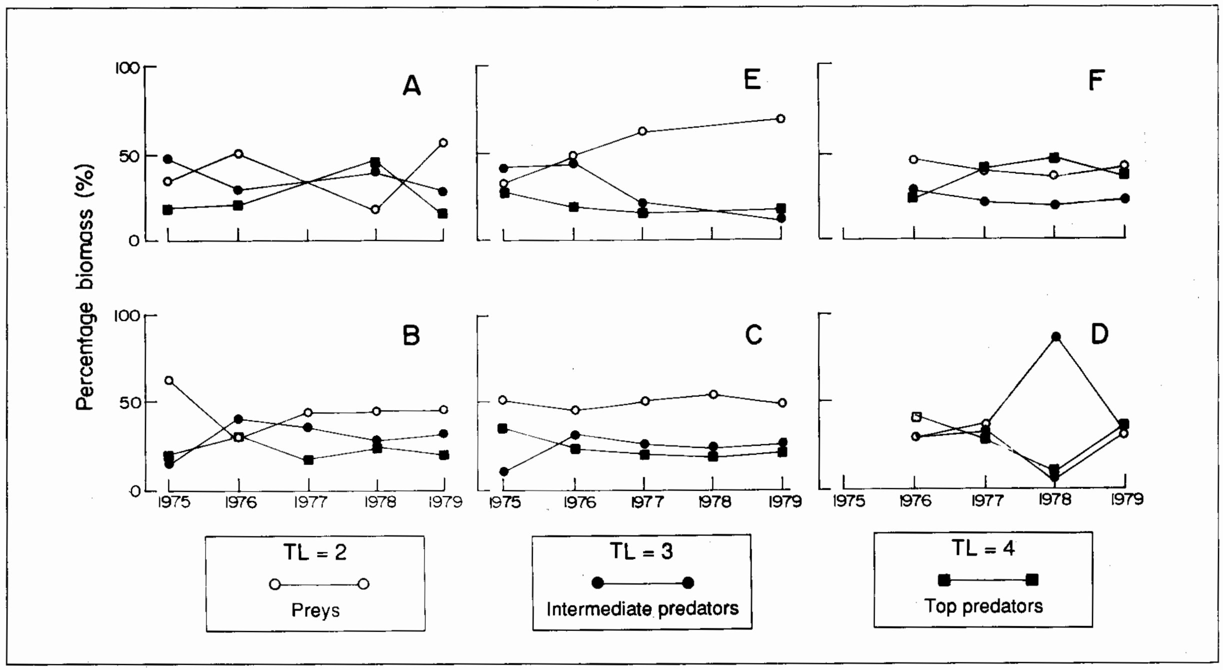

Fig. 10. Trend of % contribution to total demersal biomass of the fish of three different trophic levels (TL = 2: preys; TL = 3: intermediate predators; TL = 4: top predators; see also Table 8) by area.
[Gambar 10. Perubahan presentase kontribusi terhahap biomass total ikan-ikan demersal yang terbagi dalam beberapa kelompok rantai makanan (TL = 2 mangsa; TL = 3 pemangsa antara; TL = 4 pemangsa puncak, lihat Tabel 8) dan menurut daerah.]

Table 9. Number of taxonomic groups contributing significantly to the first two principal components (n), relative to the total number of groups at each trophic level (N), by area (A, C-D, E-F).
[Tabel 9. Jumlah grup taksonomi pendukung penting dua komponen pokok awal (n), dibandingkan dengan jumlah total grup dalam tiap jenjang rantai makanan (N) berdasarkan daerah (A, C-D, E-F).]

Trophic level\area	A		C-D		E-F	
	n	N	n	N	n	N
2 (prey fish)	4	8	3	8	5	8
3 (intermediate predators)	7	17	9	17	9	17
4 (top predators)	5	13	6	13	6	13

South coast of Kalimantan

Although surplus-production analysis could not be applied to the sparse data from the south coast of Kalimantan, PCA was performed to examine seasonal variations of the stocks. The results indicate that 76.4% of the variation of the total demersal resources can be explained by the first two principal components (Table 7). Significant positive contributions to PC-1 were made by the sharks and rays, Ariidae, Clupeidae, Drepanidae, Heterosomata, *Lactarius lactarius*, Leiognathidae, Muraenesocidae, Polynemidae, Pomadasyidae, Sciaenidae, Scombridae, cuttles and shrimp (Fig. 9A), while negative contributions were made by the Balistidae and *Thenus orientalis* (Fig. 9B).

PCA and functional group analysis

The foregoing shows that PCA could be used to reduce much of the multivariate data matrix of trawl catches to two principal components, and to identify taxonomic groups that made significant contributions to the change in abundance of the demersal group as a whole.

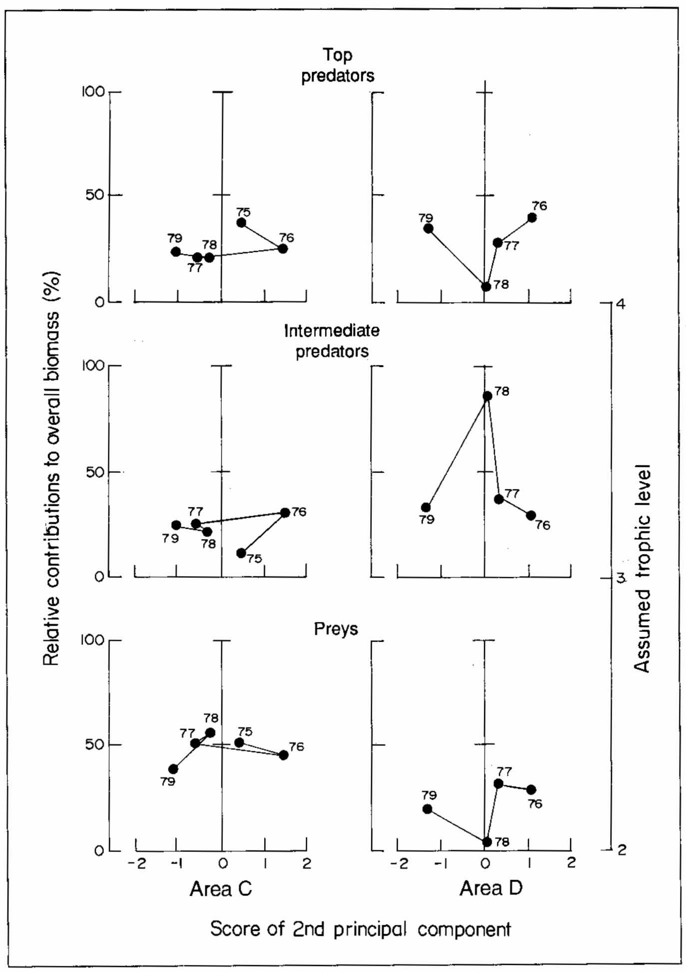

Fig. 11. Plots of % contribution to total demersal biomass of various trophic levels against second principal component scores in two areas of the North Java coast: left: area C, 1975-1979; right: area D, 1976-1979.
[Gambar 11. Grafik persentase kontribusi terhadap biomass total ikan-ikan demersal dari berbagai tingkat rantai makanan terhadap nilai komponen utama yang kedua di dua daerah utara Jawa: kiri: daerah C, 1975-1979; kanan: daerah D, 1976-1979.]

All areas 1975-1979

	A	B	C	D	E
B	0.777				
C	0.768	0.874			
D	0.739	0.830	0.817		
E	0.691	0.853	0.798	0.673	
F	0.639	0.797	0.683	0.725	0.831

Areas C and D North coast of Central and East Java

	1975	1976	1977	1978
1976	0.654			
1977	0.757	0.842		
1978	0.672	0.809	0.834	
1979	0.772	0.768	0.941	0.815

Areas A - D: Southeast Sumatra and North Java coasts

	1975	1976	1977	1978
1976	0.860			
1977	0.762	0.812		
1978	0.871	0.860	0.849	
1979	0.748	0.781	0.927	0.834

Areas E and F: (South Kalimantan)

	1975	1976	1977	1978
1976	0.757			
1977	0.602	0.862		
1978	0.545	0.730	0.829	
1979	0.602	0.858	0.926	0.873

Fig. 12. Rank correlations among areas, from 1975 to 1979 and among years, for various areas, of the taxonomic components in Java Sea trawl survey catches (all significant at $p < 0.01$).
[Gambar 12. Korelasi berdasarkan ranking antar daerah, dari tahun 1975 hingga 1979, dan antar tahun, untuk berbagai daerah, dari grup taksonomi di Laut Jawa (semua nyata pada $p < 0.01$).]

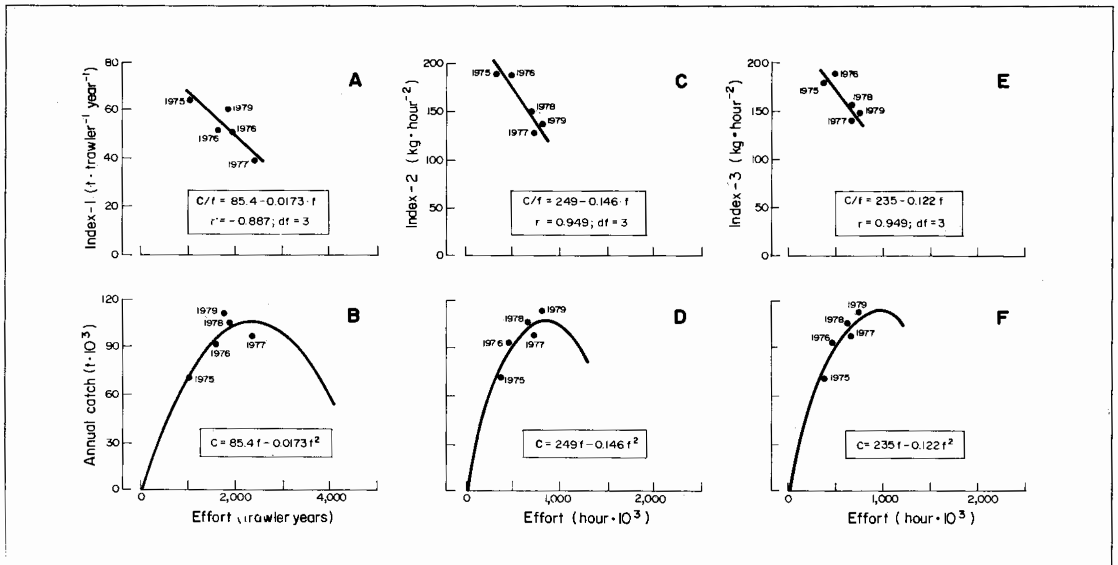

Fig. 13. Surplus-production analyses of the demersal fisheries along the Southeast Sumatra and North Java coasts (areas A-D), 1975-1979, using different indices of catch/effort and effort: Index - 1: based on catch (from fisheries statistics)·trawler^{-1}·year^{-1}; Index - 2: based on trawl survey catch·hour^{-1}; Index - 3: based on transformed trawl survey catch·hour^{-1} (see also Fig. 6).
[Gambar 13. Analisis surplus produksi dari perikanan demersal didaerah tenggara Sumatra dan pantai utara Jawa (daerah A - D), 1975-1979, dengan beberapa indeks hasil tangkapan per upaya. Indeks - 1 : berdasarkan hasil tangkapan (data statistik perikanan)·kapal^{-1}·tahun^{-1}; Indeks - 2 : berdasarkan hasil tangkapan trawl (survei)·jam^{-1}; Index - 3 : berdasarkan transformasi hasil tangkapan trawl·jam^{-1} (lihat Tabel 6).]

Table 10. Correlation among pelagic, demersal, total catch and principal component (1 or 2)[a].
[Tabel 10. Korelasi antara hasil tangkapan sumberdaya pelagis, demersal, total hasil tangkapan dan komponen pokok[a].]

Dependent variable	PC	Areas A-D	Areas C-D	Areas E-F
Pelagic group	1	-0.87* (-0.97)**	0.29 (0.24)	0.89** (0.92)**
	2	-0.26 (-0.22)	-0.49 (-0.87)*	0.34 (0.17)
Demersal group	1	0.78* (0.84)*	0.51 (-0.27)	0.87* (0.98)**
	2	0.59 (0.47)	0.85* (0.85)*	0.38 (0.08)
Total catch	1	0.67 (0.70)	-0.50 (-0.25)	0.89** (0.99)**
	2	0.74 (0.57)	0.84* (0.74*)	0.38 (0.10)

[a]Values within brackets were based on 17 taxonomic groupings; * significant at $p < 0.10$; ** significant at $p < 0.05$.

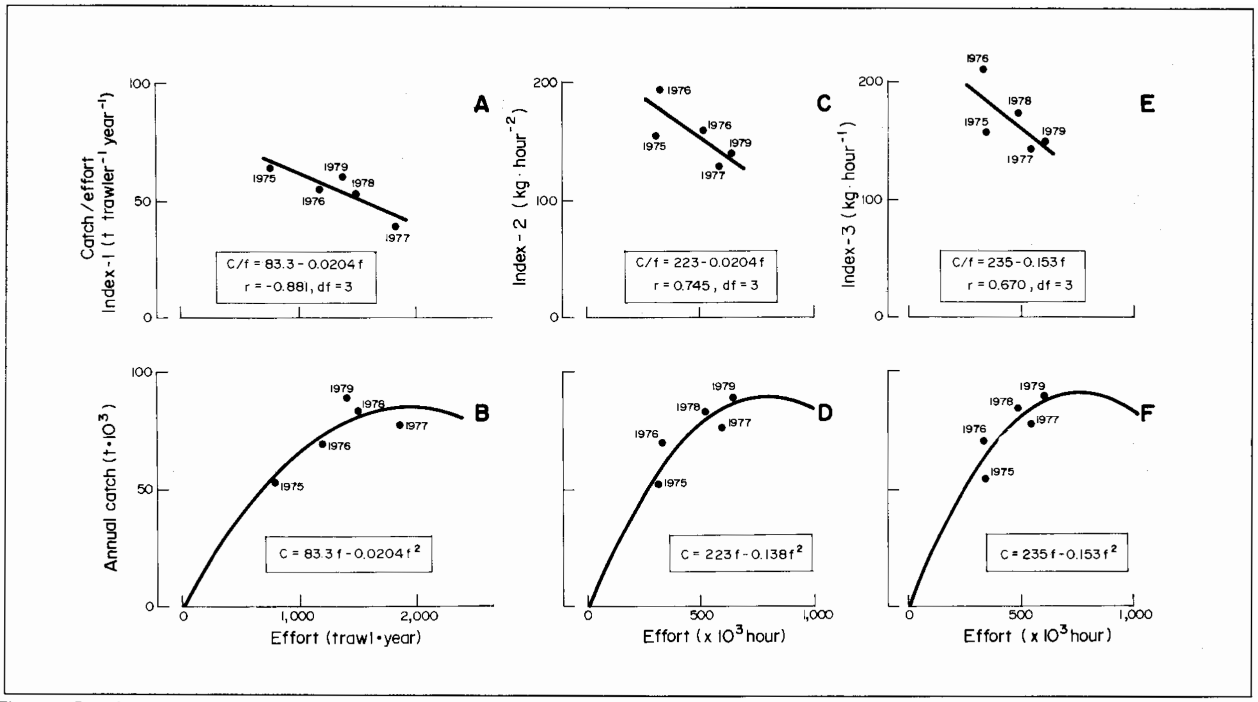

Fig. 14. Surplus-production analyses of the demersal fisheries along northern coast of Central and East Java (areas C-D), 1975-1979, using different indices of catch/effort and effort: Index - 1: based on catch (from fisheries statistics)·trawler^{-1}·year^{-1}; Index - 2: based on trawl survey catch·hour^{-1}; Index - 3: based on transformed trawl survey catch·hour^{-1} (see also Fig. 6).
[Gambar 14. Analisis surplus produksi dari perikanan demersal di pantai utara Jawa Tengah dan Timur [daerah C-D], 1975-1979, dengan beberapa indeks hasil tangkapan per upaya. Indeks - 1: berdasarkan hasil tangkapan (dari data statistik perikanan)·kapal^{-1}·tahun^{-1}; Indeks - 2: berdasarkan hasil tangkapan trawl (survei)·jam^{-1}); Indeks - 3: berdasarkan transformasi hasil tangkapan trawl ·jam^{-1} (lihat Tabel 6)].

The present study was, unfortunately, based on only five years' worth of data. Still, it was possible to identify those taxonomic groups which significantly contributed to the total variation of demersal groups in different areas experiencing different degrees of fishing pressure. The percentage contribution of the first two principal components was around 75% of total variation both for the lightly exploited areas (areas E and F) and the highly exploited areas (areas C and D). However, there was a large difference in the number of taxonomic groups significantly contributing to the first two principal components. Whether this difference was caused by differences in fishing pressure, by interspecific interactions among taxonomic groups, or by a combination of these cannot be resolved.

An attempt was also made, based on literature data, to assign trophic levels (TL) to the various taxonomic groups, i.e., prey fish (TL = 2), intermediate predator (TL = 3) and top predator (TL = 4), i.e., assuming small prey fish to feed directly on primary producers and on detritus (for which TL = 1 in both cases, see contributions in Christensen and Pauly 1993). The hypothesis to be tested here was whether the fishes of different trophic levels (Table 8) to the total variance in three areas were exposed to different degrees of fishing pressure.

No significant difference was detected (using an χ^2 analysis) for any of the trophic levels (Table 9).

Another way to test whether the stocks underwent changes in trophic structure over time is through an examination of the trophic level contribution to the time series. Fig. 10 shows that, in general, only minor changes of trophic level contribution to overall biomass occurred, except in Area D, where only a small number of trawl hauls were made in 1978. This suggests that increased fishing, at least from 1975 to 1979, has had only a minor effect on the trophic structure of the demersal communities of the Java Sea, as also confirmed by the lack of trends in Fig. 11, and by Fig. 12, documenting the stability of the ranking of different taxa among years and areas.

PCA AND SURPLUS-PRODUCTION MODELS

The entire "demersal" catch has been used for the surplus-production analyses documented in Figs. 13 and 14. These indicate that overall fishing effort was, in the late 1970s, not in excess of that needed to generate MSY, irrespective of which measures of catch and effort are used.

Table 10 shows that the "demersal" groups have, in Areas A-D, C-D, and E-F, significant positive correlations with PC-1 and PC-2. Significant positive correlations also occur between the "total catch" and the principal components in Areas C-D and E-F. The latter appears to be caused by a strong negative correlation between the "pelagic group" and the principal components.

In general, the "pelagic group" is negatively correlated with the principal components (except in Areas E-F where the pelagic fishing effort is slight) which may be attributed to a significant contribution of some pelagic fishes to the variation of the total catch (see above).

Application of the surplus-production model to total biomass of the demersal resources in the tropics has generally been based on the index of abundance derived from the total catch rate of a bottom trawl, as done in the analysis of demersal resources in the Gulf of Thailand (FAO 1978), and those off the north coast of Java (Dwiponggo 1978). Since some pelagic fishes are represented in the trawl catch, the estimate of MSY for the demersal resources will obviously include the pelagic component. Thus, unless the pelagic group represents a small portion of the total catch, estimates of MSY for the trawl fishery must be taken with a grain of salt, particularly when the pelagic group is also negatively correlated with the principal component, as in the present analysis.

Overall, it would thus seem best, when dealing with catch and effort data from bottom trawl fisheries, to separate the truly demersal fishes from the pelagics caught incidentally, and which can be defined both in taxonomic/ecological terms, and through their correlation with the first and second components of a PCA.

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Narrative and Major Results of the Indonesian-German Module (II) of the JETINDOFISH Project, August 1979 to July 1981

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Abstract

An account is presented of a series of Indonesian-German trawl survey cruises conducted from August 1979 to July 1981 in the framework of the multiagency "Joint Eastern Indian Ocean Fisheries Survey" (JETINDOFISH).

The area surveyed - mainly through demersal trawling - covered 70,000 km^2 of shelf from the central coast of Sumatra to Java and Bali.

The survey and sampling methodologies are described in some details, such as to allow replication of estimates of what was, during the survey period, a largely unfished biomass.

Abstrak

Sekilas pemaparan tentang hasil-hasil pokok dari rangkaian survei Indonesia-Jerman dari bulan Agustus 1979 hingga Juli 1981 dalam rangka kerjasama antar beberapa instansi yang dikenal dengan nama "Joint Eastern Indian Ocean Fisheries Survey (JETINDOFISH)".

Daerah yang disurvei - terutama melalui trawling sumberdaya ikan demersal - meliputi wilayah seluas 70,000 km^2, yakni daerah paparan perairan dari pantai tengah Sumatra hingga ke Jawa dan Bali.

Metode survei dan cara pengambilan contoh diketengahkan secara rinci sedemikian rupa sehingga memungkinkan replikasi penghitungan estimasi dalam kurun waktu survei terhadap biomassa sumberdaya yang mana pada waktu survei dilakukan sebagian besar masih belum tereksploitasi.

Introduction

The work reported upon here was performed within the framework of the "Joint Eastern Indian Ocean Fisheries Survey" (JETINDOFISH), a project conceptualized by members of the Indian Ocean Fishery Executive Committee during meetings held in Rome and Mombasa in 1974. During these workshops, it became apparent that there was very little information available on fish stocks of the eastern and southeastern Indian Ocean, i.e., south of the Indonesian archipelago and on the northwestern shelf of the Australian continent.

The committee and representatives of the Food and Agriculture Organization (FAO) and the United Nations Development Program (UNDP) therefore agreed to launch a major exploratory fishing survey in the area, based on the assumption that it contained large resources so far not utilized because of the very narrow shelves, unsuitable trawling grounds, rough seas, inaccessible coasts, and lack of fisheries support facilities and markets.

This was especially applied to the southern waters of Indonesia which, by that time, had only a limited fishery on pelagic stocks. These were thought to be abundant, as suggested by the occurrence of a small upwelling in the Bali Strait, then thought to extend well beyond that area (Cushing 1971). Evidence to the contrary (Venema 1976) came too late to affect this project (see Venema, this vol.).

The project was implemented in three phases:

The **Preparatory Phase**. This was funded and carried out in 1976 by the Indian Ocean Programme (IOP) of the Indian Ocean Fisheries Commission, with assistance from the Free Hanseatic City of Bremen (Federal Republic of Germany).

The **Survey Phase**. Contrary to original plans, UNDP was in no position to fund this phase, and therefore, a multinational effort was undertaken to find funding for the project. This led to the Governments of Indonesia and Australia agreeing to embark on a major joint fishery survey in eastern Indonesia and northwestern Australia. Also, the Government of Indonesia received assistance to conduct a survey through a technical cooperation project from the Government of the Federal Republic of Germany, in the form of a chartered research vessel, and of personnel and equipment. The implementing agencies were to be the Directorate General of Fisheries (DGF), Ministry of Agriculture, on the Indonesian side, and the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), GmbH (German Agency for Technical Cooperation) on the German side. This project phase lasted from August 1979 to July 1981.

The **Evaluation Phase**. This stage was for the data to be analyzed and a first set of results to be published. Subsequent to this, recommendations derived from detailed analysis of the data obtained in the course of the surveys were to be provided concerning the improved utilization of the resources, and various pilot projects were to be implemented to increase catches, to improve processing and marketing methods and facilities, and to develop the fisheries infrastructure.

Coordination and standardization of the survey activities were entrusted to FAO, which seconded coordinators (Dr. W. Brandhorst, later Dr. T. White).

This final phase was not implemented as anticipated. Particularly, a software package previously developed for analysis of trawl data in the Persian Gulf failed to perform, and only averaged catch rates (by area, by depth, etc.) became available for analysis and reporting before the project ended, hence this contribution and the others in this book (see also Pauly, this vol.).

Materials and Methods

The Surveys

The area surveyed by the JETINDOFISH project stretches from Sumatra to the northwestern shelf of the Australian continent. This area was subdivided into three "Modules". One of these (Module II) extended from Sumatra to the degree of longitude that crosses the island of Bali (Fig. 1). The fisheries research vessel, *FRV Jurong*, with a displacement of 300 GT and LOA of 30 m was commissioned

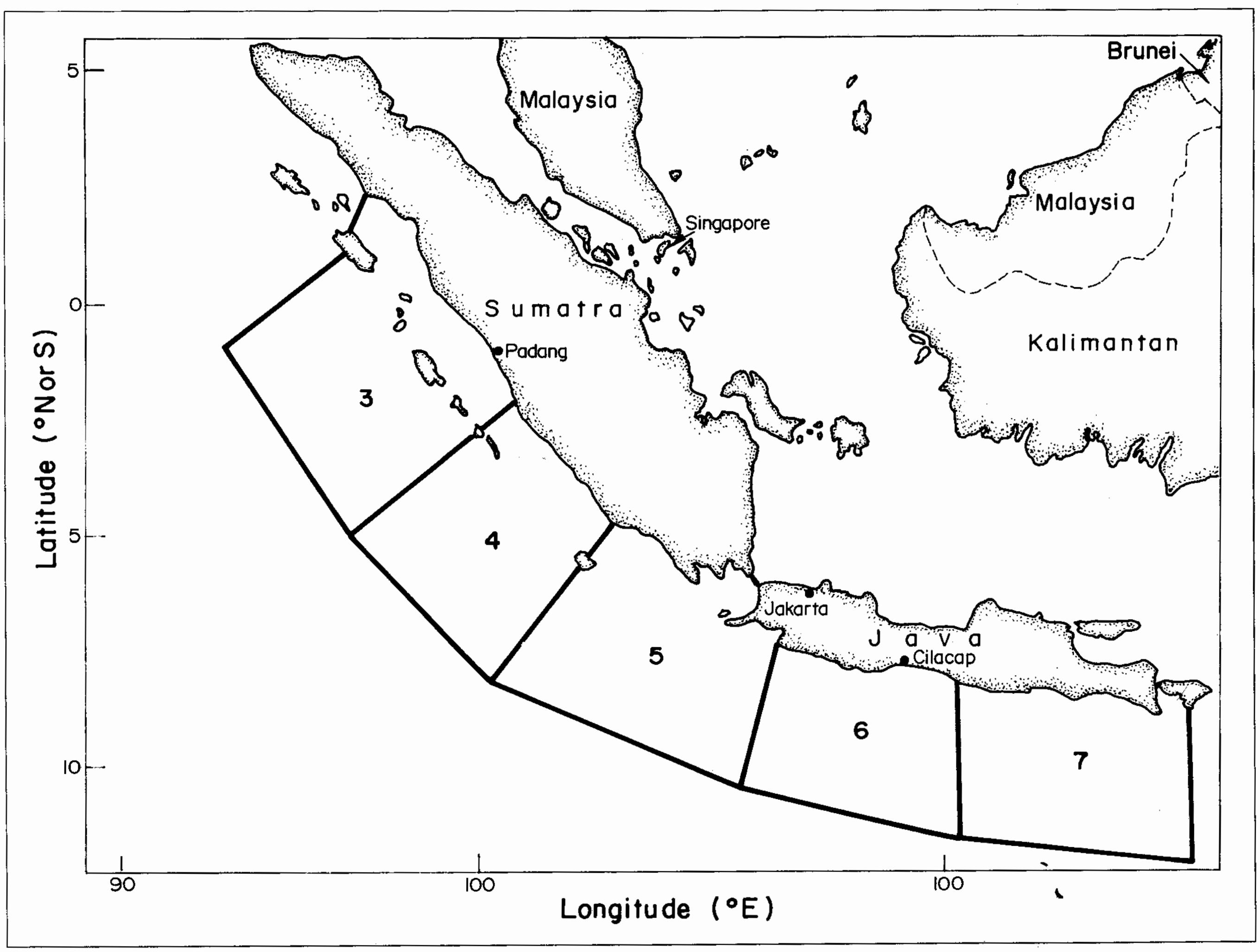


Fig. 1. Definition of that part of the Indian Ocean coast of Indonesia covered by areas 3-7, Module II of JETINDOFISH. Areas 1 and 2, as initially defined, were not surveyed and are not shown.
[Gambar 1. Bagian dari Samudra Hindia wilayah Indonesia (area 3-7), JETINDOFISH Modul II. Daerah 1 dan 2, sebagaimana dijelaskan sebelumnya, tidak diliput didalam survei, oleh karena itu tidak ditampilkan ini.]

to conduct the survey in Module II.

Module I was located to the east of Module II, and extended to the northwestern shelf of the Australian Exclusive Economic Zone in the Arafura Sea. Module I was surveyed by *FRV Bawal Putih 2* (see Martosubroto, this vol.).

The Australian northwestern shelf (Module III) was first surveyed by *FRV Courageous*, later by *FRV Soela*. Both vessels were made available by the Australian Ministry of Primary Industry.

Modules I, II and III were surveyed independently from each other; however, most activities and sampling protocols were standardized by an Advisory and Technical Committee composed of members of all agencies involved in the JETINDOFISH project. All modules were subdivided into "areas". Only the results of the survey performed in Module II are presented here.

The main objective of the survey was to gather data for an assessment of stock density. This was to be achieved by collecting catch/effort data and combining these with readings from echointegrators, as gathered during acoustic surveys.

It was clear from the beginning of the project that the vast expanses of the survey area and the limited time available would allow to take samples only at a relatively small number of stations. It was assumed that this constraint would curtail the accuracy and precision of the findings, but would yield at least a rough estimate of stock density and abundance, sufficient for a decision on whether or not to encourage the development of commercial fisheries, and possibly to decide on some of their technical features.

In addition, an attempt was made to describe the hydrography of the area by collecting data from a bathythermograph (BT) and by regularly recording sea surface temperatures (SST).

The survey was also expected to help answer the question whether the acoustic equipment installed on board the vessel was a cost-efficient tool that could be employed to explore and monitor fish stocks. The answer to this question was of particular importance since a portion of the resource was already subjected to exploitation through established, if ill-documented artisanal fisheries (see Venema, this vol., and Ghofar and Mathews in Pauly et al., this vol.).

Box 1. Vessel specifications of *R/V Jurong*.
[Boks 1. Spesifikasi kapal penelitian Jurong.*]*

Type stern trawler, Class + 1A	
Main dimensions:	
Length O.A.	35.0 m
Length B.P.P.	31.7 m
Breadth MLD	7.9 m
Tonnage	213.25 BRT
Capacity:	
Freshwater tanks	27 m^3
Fuel oil tanks	57 m^3
Lubricant oil tanks	2 m^3
Tunnel freezer	-30°C (3 t day^{-1})
Freezer	-18°C
Engine and performance	
Main Engine CATERPILLAR Type D 398 TEF	
750 HP 1225 RPM	
(controllable pitch propeller)	
Max. speed	12.5 kn
Main fishing winch	Hydraulik A/S Dia 10/4
	Wire capacity 1400 m; ϕ 18 mm

The Survey Vessel

FRV Jurong, used for surveying Module II, had the characteristics of a stern trawler (Box 1). This vessel was formerly commissioned as a fisheries training vessel and was chartered for the survey by GTZ from the UNDP/FAO vessel pool.

Given its original design and previous utilization, it had sufficient space to accommodate the crew and a number of scientists and technicians, and to process catch samples according to established scientific standards. The vessel's engine, rated at 555 kW, was adequate to tow the bottom trawl at speeds of up to 5 kn. With increasing depth, trawling speed however became reduced; at depths of more than 250 m the standard speed of 3 kn could not be maintained, and at the maximum fishing depth (380 m), the trawling speed was only 1.2 kn.

The vessel was of a shelter-decked type. The catch was hauled in via a stern ramp to the upper deck, then cleaned and brought forward to a hatch from where it came down to the steerage and processing deck, where the fish were sorted and recorded. Individual fishes suitable for processing were preserved, i.e., frozen in the deep-freezing compartment. Navigational equipment included a gyro compass, radar, echosounder, sonar, and satellite and radio navigation systems.

The vessel had a full complement of Indonesian officers and crew. The German counterparts consisted of a captain/masterfisher, a chief mate, two engineers who trained their counterparts in vessel operations and fishing techniques, and an electronics specialist responsible for operation and maintenance of the electronic equipment. Another land-based expatriate, a vessel operation manager, was responsible for logistics.

Three Indonesian fisheries biologists and three technicians were permanently assigned as counterparts to the German team. In addition, a total of 20 Indonesian biologists, technicians and one student received hands-on training during 32 of the cruises.

The FAO/UNDP coordinator participated in several cruises with the main objective of standardizing the data collection according to the criteria set by the coordinating FAO/UNDP body. During three cruises, a total of 11 guests and short-term consultants joined the survey, particularly to assist in the taxonomic work.

Box 2. Navigation and echosounding equipment of *FRV Jurong*.
[Boks 2. Peralatan navigasi dan echosounding dari FRV Jurong.*]*

Navigation:

DECCA Radar D 202
KELVIN HUGHES Radar 18/12
MAGNAVOX Satellite Navigator MX 1102 - NV
SIMRAD Sounder EQ 50
TOKYO KEIKI Gyro-Compass
BERGEN NAUTIK Magnetic Compass
KELVIN HUGHES Pentland Bravo Radio DRG
KELVIN HUGHES Foreland VHF Radion 801 A
BERGEN NAUTIK Electric Log

Echosounding:
SIMRAD Scientific Sounder EK 38 (38 kHz)
SIMRAD Scientific Sounder EK 120 (120 kHz)

SIMRAD SK 3 Sonar

SIMRAD CI - Scope connected to the sounder, and to a SIMRAD MC - Magnifier.

SIMRAD Echo Integrator QM - MK II
HEWLETT PACKARD 7702 B Recorder

SIMRAD EX Netsonde

Test and calibration equipment:

HEWLETT PACKARD 141 B Storage Oscilloscope
WAVETECK 116 Signal Generator
Frequency Counter
Voltmeter
Hydrophone

KAHL Bathythermograph (0-250 m)
KAHL 250 WA 100 Meter Wheel

The Electronic Equipment

A sonar and a Simrad QM-MK II echointegrator were used for locating and assessing fish aggregations (Box 2). Basically, the instruments consists of a specially designed transducer coupled to an electronic processor. All electroacoustic equipment, with exception of the sonar and the net sonde, were kept in *Jurong's* airconditioned chart room for protection against excessive humidity. For fish detection, either one of the two scientific sounders - SIMRAD EK 38 (operating at 38 KHz) and SIMRAD EK 120 (120 KHz) - or the navigational sounder, SIMRAD EQ 50 KHz was operated. For actual sampling, the EK 38 was used because the shortwave oscillations of the EK 120 had a depth range limited to about 100 m. During operation of the integrator, the types and spatial distributions of echoes were logged in form of echograms. Thus, it was possible to directly associate the integrator readings with the characteristics of the echoes.

The echosounder converts into electric impulses the echoes that are received by the transducer from individual fish or fish aggregations. The integrator then sums these impulses, while compensating for distance and other variables. Readings from the latter instrument were assumed proportional to the biomass of the particular fish aggregations in question.

An MC-Magnifier screen was attached to the integrator to display simultaneously and continuously both fish aggregations and signal strengths. Detailed analysis of individual signals was performed using a fish scope. The navigational echosounder working at a frequency of 50 kcycles was used during trawling operations and during acoustic surveys to detect concentrations of fish at the shelf's margin and slope. However, when switched on for fish detection in the surface layer, the sonar (SIMRAD SK 3) often caused interference with the echosounder. One unit each of oscilloscope, signal generator, frequency counter, voltmeter and hydrophone were used to test and calibrate the electroacoustic equipment.

Individual fish in the vicinity of the net opening could be detected by a net sonde. This instrument, however, was attached to the headrope only when the risk of losing gear and instrument was low, i.e., when the bottom was smooth.

The vessel was also equipped with a winch for a bathythermograph: recordings to depths of 200 m were made regularly throughout the survey.

The Demersal Trawl

A high-opening bottom trawl of 527 meshes circumference with 200 mm (stretched) mesh was used, with a rather large codend mesh size of 40 mm (Fig. 2). The headline carried floats of 20-cm diameter; the ground rope was mounted alternately with rubber discs of 30- and 50-cm diameter at a spacing of approximately 50 cm, and fitted with chains. The dry weight of the ground rope was approximately 675 kg. The bridles were 53-m long at 14-mm diameter. The vertical net opening at a trawling speed of 3 kn was 4.5 m. The horizontal net opening was 25 m on the average, depending on the nature of the sea bottom, and was measured by gauging the angle of spread of the warplines. The area swept during a one hour tow at 3 kn was estimated at 0.1389 km^2.

The otter boards measured 2.6 x 1.5 m, were oval-shaped, had interchangeable steel shoes, and weighed between 600 and 650 kg each.

The Pelagic Trawl

The four-seam midwater trawl used during the surveys had 308 meshes circumference at 800 mm (stretched mesh), was made of 100% high-quality nylon twine for optimum elasticity and was designed for the capture of small pelagic fishes (Fig. 3, inset). Sets of five floats each were mounted to the headrope for static buoyancy. The codend had a mesh size of 40 mm (stretched mesh) and was equipped with a splitting strap. Bridles were 70-m long at 14-mm diameter. Steel weights of 300 kg each were attached to the lower tips of the wings in order to give the mouth opening of the net a more or less permanent rectangular shape. The otterboards were 2.55 x 1.5 m in size, symmetrical and could be used on either side of the ship.

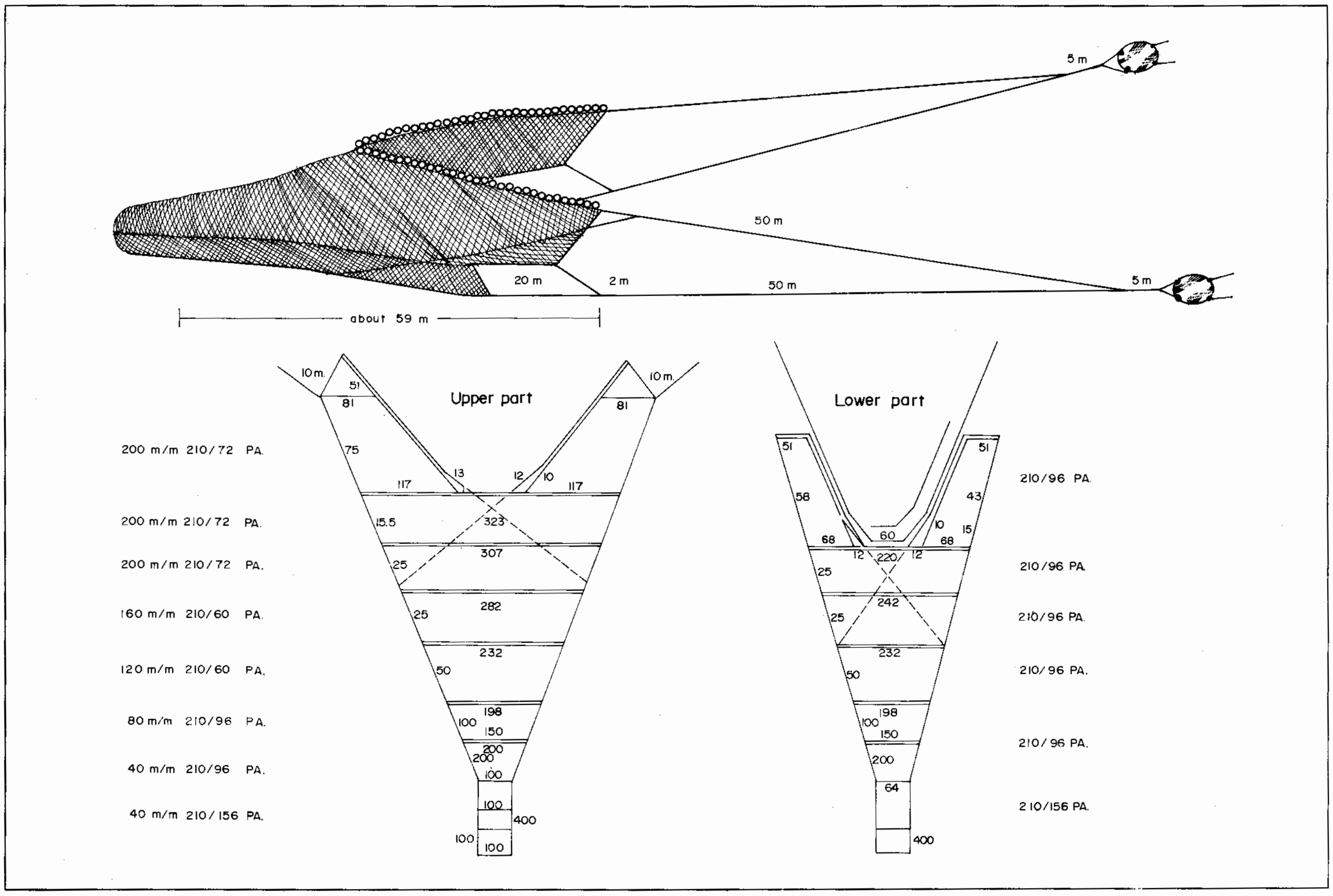


Fig. 2. Schematic representation of the otter trawl used for sampling demersal fish.
[Gambar 2. Diagram otter trawl yang dipakai untuk pengambilan contoh ikan demersal.]

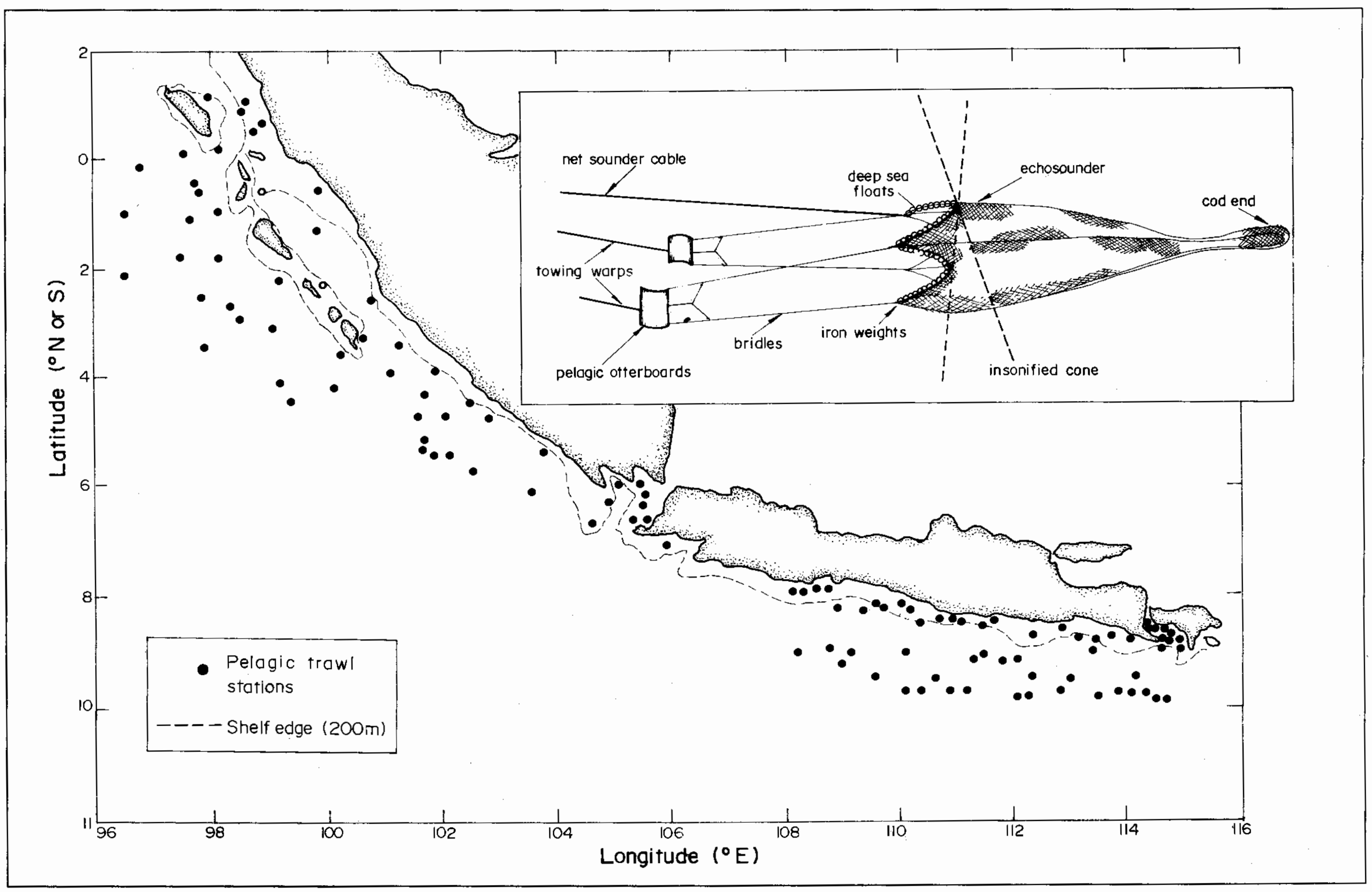


Fig. 3. Pelagic trawl stations covered by Module II of JETINDOFISH (inset: the sampling gear).
[Gambar 3. Stasiun trawl pelagis dari JETINDOFISH Modul II (sisipan: gambar trawl, alat tangkap yang digunakan).]

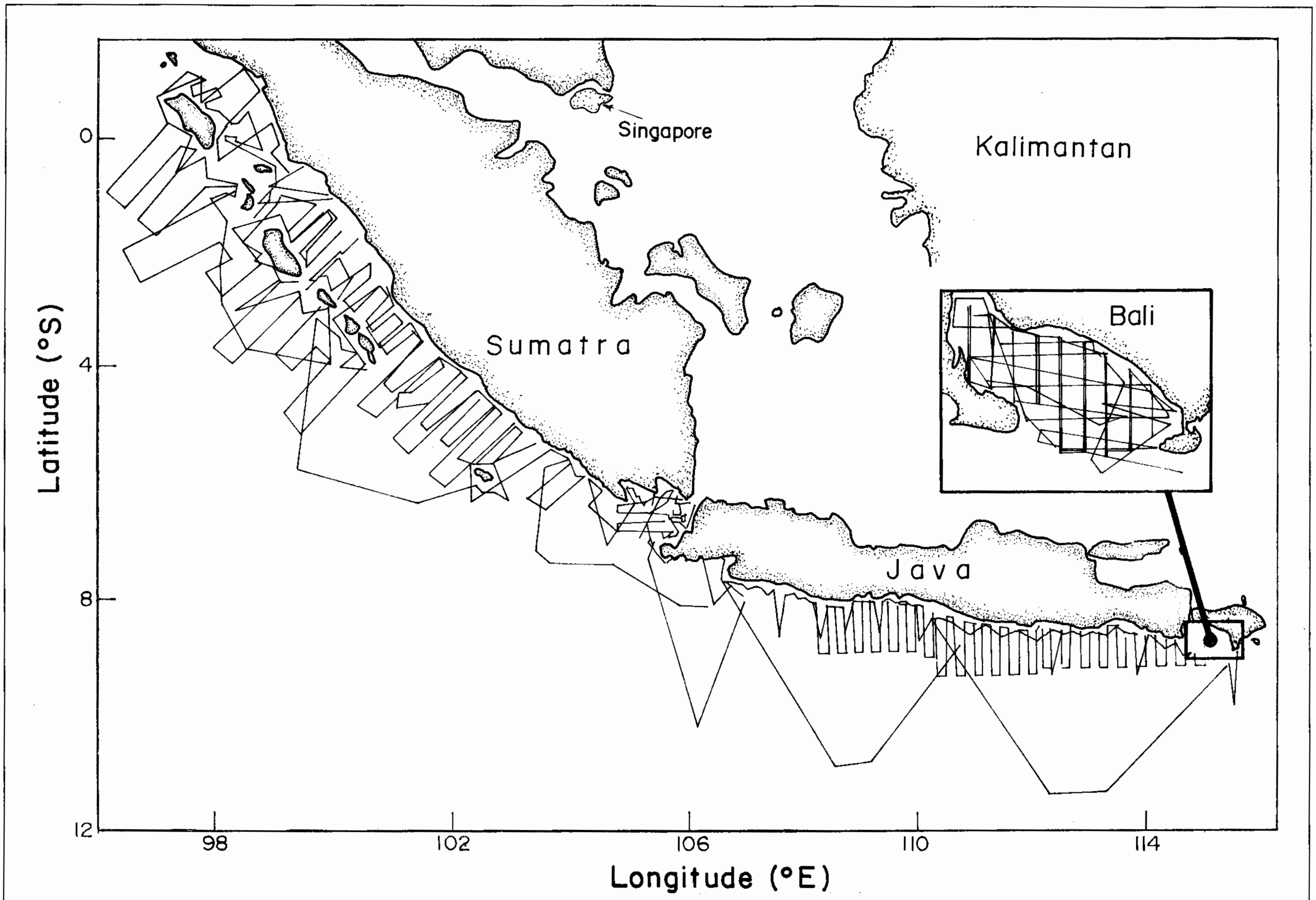


Fig. 4. Cumulative cruise tracks of *R/V Jurong*, as followed during the combined acoustic, trawling and hydrographic surveys lasting from August 1979 to July 1981. Note rectangular shapes, allowing even coverage of the shelf, from inshore to deeper waters.
[Gambar 4. Liputan kumulatif pelayaran kapal Jurong *selama kegiatan survei terpadu yang menggunakan peralatan akustik, trawl dan hidrografi, yang berlangsung dari bulan Agustus 1979 hingga Juli 1981. Perhatikan garis pelayaran yang menyerupai persegi panjang, menandakan liputan paparan yang merata dari perairan dangkal hingga ke perairan dalam.]*

Some 154 midwater trawl operations were performed during the survey (Fig. 3). Cruise tracks were determined ahead of each voyage. Sailing along these tracks and with the echointegrator continuously running, large fish aggregations were supposed to be caught once they were detected by the sonar and/or the sounders. Whenever bigger schools of fish were detected, the net was shot regardless of the hour of the day. However, only a very limited number of such hauls were made due to the absence of large fish concentrations.

A standard procedure of midwater sampling was implemented to routinely verify readings received by the integrator. These so-called "standard fishing operations" were carried out early mornings, at noon and late in the afternoon and/or during night time. The main purpose of these operations was to sample the upper 8-m layer of the water column since this horizon could not be surveyed by the electroacoustic equipment. Once the net was hauled in, the vessel returned to the position where the net was shot and continued with the acoustic survey, following the predetermined cruise tracks. Nearly 12,000 nm of tracks were covered this way, twice from Bali up to Nias Island, and once each during the southeast and northwest monsoon periods (Fig. 4).

Fish Species Identification

Species identification required a considerable effort. There were quite a number of identification keys dealing with the fish fauna of the tropical Indo-Pacific. However, with a few exceptions (see below), these works were not appropriate for shipboard use. Neither was a single comprehensive key available which would have allowed for reliable identification of the species likely to be encountered in the survey area. Quick and correct identification was therefore very difficult. Most shipboard identifications were based on the *FAO species identification sheets for fishery purposes: Eastern Indian Ocean (Fishing Area 57) and Western Central Pacific (Fishing Area 71)* edited by Fischer and Whitehead (1974); *Coastal fishes of South Japan* (Masuda et al. 1980), *Coastal fishes of New Guinea* (Munro 1967) and *The fishes of the Indo-Australian Archipelago* (Weber and de Beaufort 1913, 1916, 1922, 1929, 1931, 1936).

Doubtful or unknown species were marked with a temporary code number, preserved and sent to a specialist. In all cases, this procedure ensured an identification down to the species level. Also, almost all species were photographed and one reference specimen each was preserved for later referral. Thus, a project-specific "field guide" emerged which gradually replaced the other identification works. This "field guide" was later published as *Trawled fishes of southern Indonesia and northwestern Australia* (Gloerfelt-Tarp and Kailola 1984).

Trawl Sampling

The *Jurong's* draught of 7.8 m precluded an investigation of nearshore waters, lagoons and reefs. On the other hand, the equipment installed on board did not permit sampling of deep water zones: for technical reasons, the echointegrator was calibrated to depths ranging between 15 and 100 m.

Likewise, the biomass of pelagic fish species near the sea surface could not be assessed reliably. Fast swimming pelagic species near the surface avoided both the trawl gear and acoustic detection. Exception to this were extensive aggregations of *lemuru* (*Sardinella lemuru*) found in Bali Strait. These caused strong signals in the echosounders and were very well sampled by the high opening bottom trawl.

FRV Jurong was commissioned for the survey of Module II for two years, from August 1979 to July 1981. During this period, 32 research cruises and 743 fishing operations were conducted, 154 of which with the pelagic trawl. The data from 515 of the remaining 592 (bottom) trawl hauls were considered to be suitable for purposes of stock assessment; 77 hauls were conducted as "simulated commercial" operations, i.e., their location was nonrandom.

For each area, the catch/effort data were used to estimate standing stock size. The decision on where fishing stations should be located was done in random fashion, as follows: prior to the survey, each area was subdivided into squares of 5 x 5 nm, and the squares numbered consecutively. Using a random number generator, the squares to be investigated were then identified. When the vessel actually visited the identified square and the echosounder indicated that the sea bottom would be too rough to allow smooth trawling, that particular square was marked in the sea chart, and the next square previously selected by the random process was visited. Later analysis of echosounder recordings, including those from untrawlable grounds, were used to classify and document the bottom topography according to its general suitability for trawl fishing.

In certain parts of the survey area - e.g., in Grajagan Bay, on the southeast coast of Java - trawlable grounds were extremely scattered and could not be sampled at random. In such cases a systematic search for smooth bottoms was conducted with trawling operations made whenever and wherever possible. Data from these hauls were not used for the estimation of biomass.

"Simulated commercial" trials with the bottom trawl were made up to three times per cruise. In these cases, the decision on where and how long to fish was left to the captain. Quite often these commercial trials were made where random fishing operations had indicated an abundance of commercially valuable species. Sampling of those catches followed the standard procedure; however, the data and results originating from these operations were also kept separate from those used for biomass assessments.

Cruise No. 24 served for intercalibration of fishing gear between *FRV Jurong* and *FRV Bawal Putih 2*. Both vessels attempted to catch as much fish as possible under simulated commercial conditions. Their fishing stations were therefore not selected at random, and the data thus gathered were likewise not used for biomass assessments. The operations included target fishing for deep water resources (<< 200 m), especially for deep sea shrimp.

Catch sampling followed the standard procedures described in Losse and Dwiponggo (1977; see also Pauly 1983). The presorted catches were weighed, and subsamples were recorded according to species and weight.

In cases where the standard time schedule of one hour trawling could not be adhered to, the weights of that haul and of its component species were corrected by applying the appropriate multiplicative factor(s). Trawling speed and net opening were usually assumed to remain constant, implying an equal average volume of water being filtered by the net and an equal bottom area being swept (see below for cases where haul-specific statistics were used to estimate the areas swept).

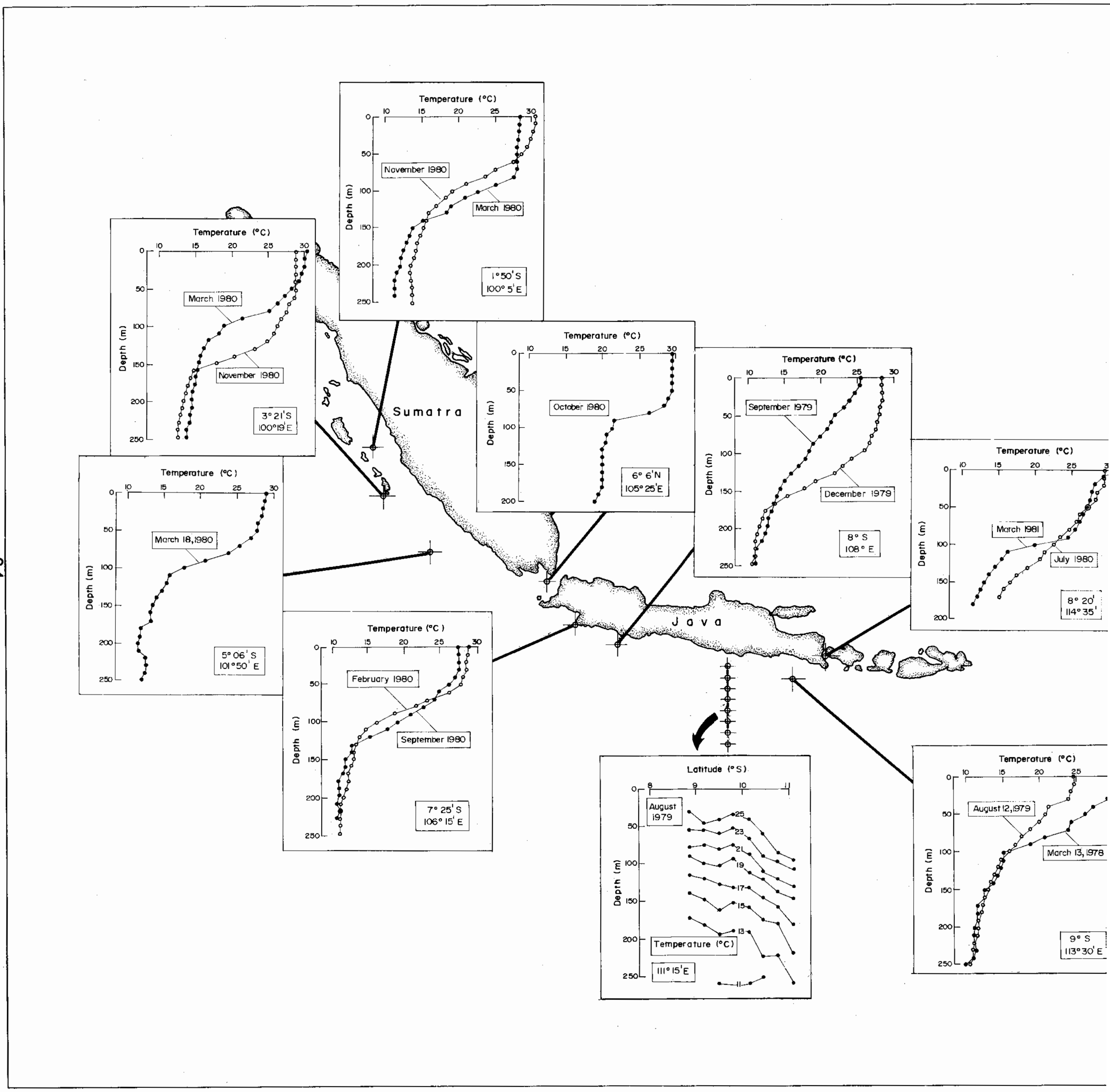
Whenever time and resources permitted, length-frequency measurements were taken. Total lengths were recorded when applicable; in cases where the caudal fin was heterocercal or where the tail end allowed no clear definition of total length, standard lengths were taken.

Assessment of Biomass

The catch/hour data were divided by the area swept to obtain estimates of relative density ($t \cdot km^{-2}$), which were averaged within previously defined depth ranges and seasons, using either arithmetic means, or geometric means in cases where the data were highly variable (see contributions in Doubleday and Rivard 1981 and Pauly 1984).

Area 7 is that part of Module II where the grid of fishing stations was most dense, compared to the other areas. Here, unit catches were directly converted into density estimates. Also, in all cases where detailed recordings were available, the actual distance which the gear travelled over ground and the actual horizontal net opening (estimated from the angle and distance between the warp lines) were used for the computation of the area swept during individual hauls.

In the other areas, and/or whenever the area swept by individual hauls could not be estimated, the mean values presented above (area covered, net opening, etc.) were used. Either approaches yielded estimates of *relative* density, which may not be mistaken for estimates of *absolute* stock density, i.e., $biomass \cdot km^{-2}$. However, one can derive approximate values of absolute stock density by multiplying relative density with the assumed catchability coefficient of the gear. This coefficient was assumed to be 0.5, a value that was subsequently verified for the similar species assemblage occurring in the Gulf of Thailand, and nets resembling ours (Pauly 1980).


Sumatra
Java
Temperature (°C)
Depth (m)
November 1980
March 1980
1°50'S
100° 5'E
March 1980
November 1980
3°21'S
100°19'E
October 1980
6° 6'N
105°25'E
September 1979
December 1979
8° S
108° E
March 1981
July 1980
8° 20'
114°35'
March 18,1980
5° 06'S
101°50'E
February 1980
September 1980
7° 25'S
106° 15'E
Latitude (° S)
August
1979
Temperature (°C)
111° 15'E
August 12,1979
March 13,1978
9° S
113°30'E

Results and Discussion

Fig. 5 summarizes some of the temperature measurements taken during the survey. The average surface temperatures of the area was established to be 29°C, confirming Wyrtki (1961). The highest temperature measured was 31°C and the lowest was 28°C; 95% of the temperature recordings deviated from the mean value of 29.5°C by only ± 0.5°C. Seasonal fluctuations of surface temperatures were hardly noticeable.

The depth of the mixed layer tended to increase from north to south, again confirming Wyrtki (1961), and varied seasonally, especially in the Sunda Strait, where during the northwest monsoon, the thermocline was found to be. 60 m higher than during the southeast monsoon, where it occured at a depth of 120 m.

Two transects were run on August 1979 southward from the Java coast, with BT's shot every 20 nm. The resulting temperature profiles (of which one is shown on Fig. 5) show isotherms inclined toward the coast, suggesting a balanced geostrophic current.

No evidence of upwellings was detected outside of the Bali Strait area, where this phenomenon is well-documented (Nontji and Ilahude 1975). This disproves earlier suggestions of upwellings along the coast of southern Java (Wyrtki 1962; Cushing 1971), but also points out that our BT-based approach - which did not include nutrient measurements - was insufficient for serious oceanographic research. The following paragraphs, dealing with primary and secondary production, were thus assembled from the published literature.

Direct measurements of primary productivity in the survey area are rare. Productivity, integrated over the entire euphotic zone, was estimated as 0.43 $g \cdot Cm^{-2} \cdot day^{-1}$ in the area south of Java and 3.7 $g \cdot Cm^{-2} \cdot day^{-1}$ south of Bali (Stehmann-Nielsen and Jensen 1957). Krey and Babenerd (1979) present productivity values of 0.5 $g \cdot Cm^{-2} \cdot day^{-1}$ for the area off eastern Java and around Bali during the southeast monsoon. During the northwest monsoon, there is generally a lower productivity, which hardly ever exceeds 0.25 $g \cdot Cm^{-2} \cdot day^{-1}$.

According to Nontji (1977) and Nontji and Ilahude (1975), the highest concentrations of phytoplankton in the area occur south of Bali (2.36 $mg \cdot m^{-3}$) and off central Java (1.4 $mg \cdot m^{-3}$), during the southeast monsoon period. Leyndekkers (1964) and Tranter (1962) report that zooplankton reach their highest biomass during the southeast monsoon. This happens when the south equatorial current is strongest, as are the upwelling along its northern flank and south of Java (Cushing 1971). Box 3 summarizes the incidental information gathered on zooplankton and micronekton.

Box 3. Zooplankton and micronekton.
[Boks 3. Zooplankton dan micronekton.]

During the activities of Module II of JETINDOFISH, not enough resources were available to do any research on the zooplankton and microplankton, although this would have provided some knowledge of the distribution of the early life history stages of fishes and/or of their food. The following observations are based on the fact that some of the larger zooplankton stuck to the meshes of the trawls (especially so in the case of the midwater trawls):

More than 70 different taxa of macroplankton were recorded, mainly fish larvae and young fishes, but also squids and crustaceans (see Boxes 4 and 5). At various stations, scattering layers were observed at night, both at depths between 120 and 150 m and close to the surface. Some of the larger components of these layers retained by our midwater trawl were typical deepwater species, such as *Chauliodus*, juvenile and adult myctophids, Gonostomatidae and postlarval and juvenile fishes of various other families, notably acanthurids, gempylids and priacanthids. Several times, huge amounts of leptocephali, squids, salps and *Pyrosoma* were caught. Particularly high number of leptocephali, over 20 liters per haul, were found around the Mentawai Islands, off southeast Java, and in the Bali Strait. Details may be found in the database described in Torres et al. (this vol.).

Pelagic Fish Distribution

Fig. 3 presented earlier shows the distribution of stations sampled using the pelagic midwater trawl, while Fig. 4 shows the cruise tracks of the acoustic surveys.

The bulk of the pelagic trawl hauls yielded zero catches, while the acoustic survey did not yield absolute estimates of biomass due to unavailability of estimates of fish target strength.

However, estimates of relative abundance were obtained (Fig. 6). These are presented, as mm deflection per nautical mile (nm), and on a seasonal basis, since strong seasonal differences of relative abundance were observed (Table 1), probably reflecting real change in biomass and not only our different sampling grids (Fig. 6). Some information on squid is gathered in Box 4 (see also the database presented in Torres et al., this vol.).

Demersal Fish Distribution and Abundance

The two gears used to map the distribution of demersal fish were bottom trawl and echosounding; the latter was important in view of the fact that the "demersal" fish stocks in the area included many species of semipelagic fishes, spending much of their time clear off the sea bottom, and because much of the survey area was too rocky and/or uneven to be sampled by bottom trawling. Integrator deflections were assigned to the pelagic category if they occurred over 10 m away from the bottom; otherwise the echoes were added to those of the true bottom fish (Fig. 9).

No particular study was made of the sea bottom, but analyses of samples that were brought to the surface by the nets and the otterboards allowed some conclusions. Supplemented by recordings of the echosounder, these provided the following picture:

The sea bottom off the southwestern coast of Sumatra is sandy to muddy whereas the shelf around the islands of Nias, Mega and Engano is of a rough and rocky nature. The bottom is interspersed with coral reef formations in the shallow waters around the islands of Tanah Bala and Pulau Pini. Adjacent to the south, the Sunda Strait is characterized in its central parts by rough banks, parts of the exploded Krakatau volcano. The

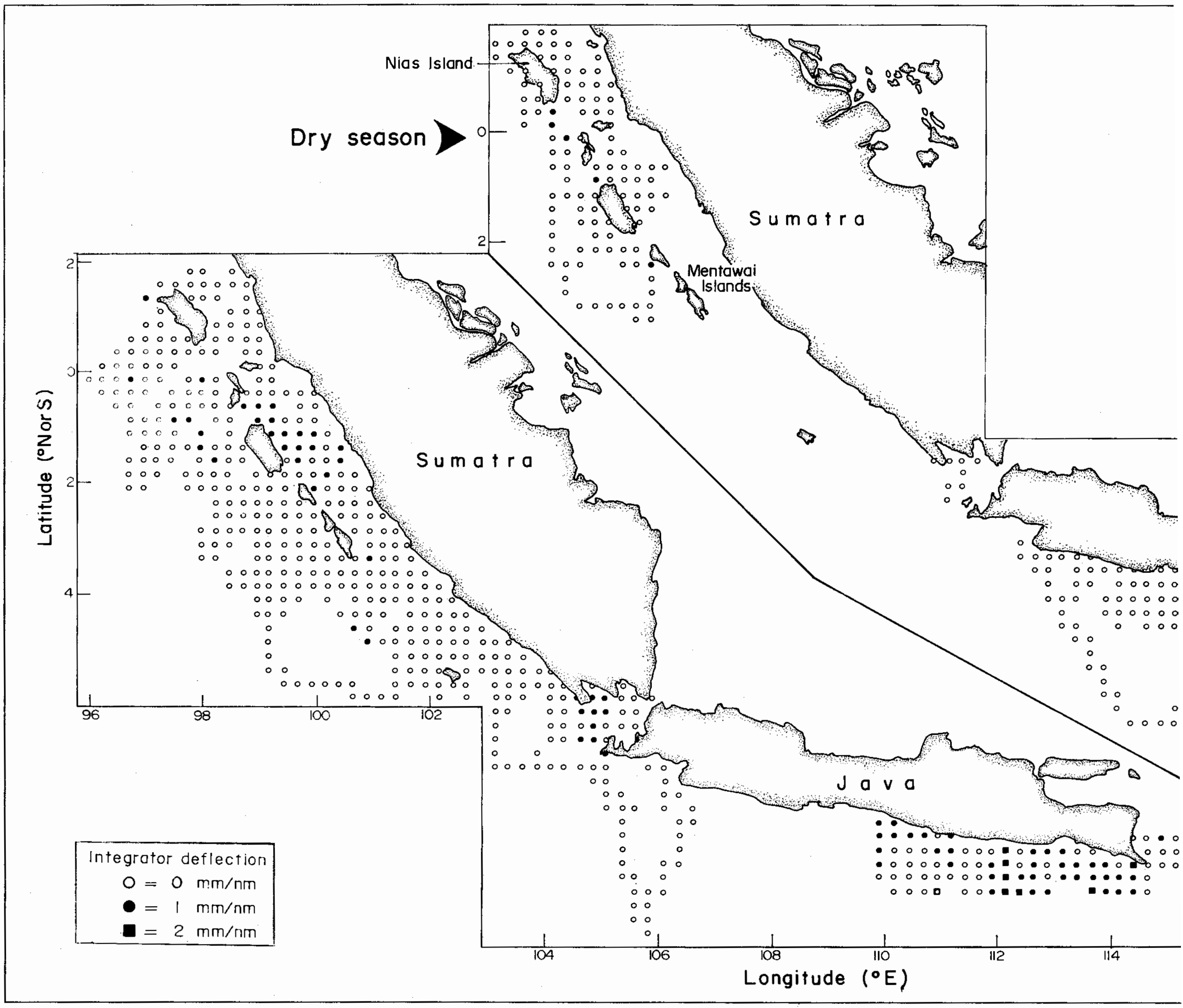


Fig. 6. Relative abundance of pelagic fish during the rainy and dry seasons from August 1979 to July 1981, as indicated by echointegration. Note that thes
than during the dry season.

[Gambar 6. Kelimpahan relatif ikan-ikan pelagis selama musim hujan dan kering dalam kurun waktu Agustus 1979 hingga dengan Juli 1981, sebagaiman kelimpahan relatif ini muncul lebih tinggi dalam musim hujan daripada musim kering.]

Table 1. Areas with low, medium and high integrator deflection, indicating relative abundance of pelagic fish during the rainy (November-March) and dry seasons (May-September).

[Tabel 1. Perbandingan rata-rata penyimpangan integrator, yang menunjukkan kelimpahan relatif ikan pelagis (dalam mm per nm) selama musim hujan (November-Maret) dan musim kering (Mei-September).]

Deflection (mm/nm)	Sumatra Rainy (Season) $nm^2 \cdot 10^3$	Sumatra Dry $nm^2 \cdot 10^3$	Java Rainy (Season) $nm^2 \cdot 10^3$	Java Dry $nm^2 \cdot 10^3$
0	76.0	25.4	27.6	41.0
1	8.6	0	10.8	1.1
2	0.2	0	2.2	0
Relative abundance[a]	0.106	0.000	0.374	0.026

[a]Obtained from area covered x mm deflection total area surveyed in that season.

Box 4. Squids caught during the JETINDOFISH survey.

[Boks 4. Cumi-cumi yang tertangkap dalam survei JETINDOFISH.]

After fish, squids were the most important marine organisms caught during the survey. The distribution of squids appeared rather homogeneous, as they were taken by bottom and by midwater trawls in every depth layer, in the entire survey area. At night, the midwater trawl often caught squids at depths of less than 150 m but these were mostly small specimens, i.e., planktonic juveniles. Squid eggs nearly ready to hatch were taken at 7 bottom trawl stations. As the mesh size used was such that many squids undoubtedly escaped through the net, these results could not be quantified.

Overall, squids were captured at more than 280 of all stations (45% of the total). The highest catch rates were obtained off Central Java, where between 30 and 129 $kg \cdot hour^{-1}$ were caught by bottom trawls at stations of about 120 m depth. Catches of 95 kg $squid \cdot hour^{-1}$ were obtained on the Sumatra Shelf, at 70 m and of 76 $kg \cdot hour^{-1}$ in the southern part of the Bali Strait, near Blambangan Peninsula, at a depth of 60 m. Squids were caught in 49 midwater trawl hauls; in five of these hauls, the gear was towed through a scattering layer which contained small pelagic squids (see Box 3).

Table 2. Summary of information on the trawlable *vs* nontrawlable bottoms in the survey area, as estimated from trawling experiments and acoustics (all areas in $km^2 \cdot 10^3$).

[Tabel 2. Ringkasan informasi keadaan daerah survei antara yang dapat ditrawl dan yang tidak, berdasarkan estimasi dari percobaan pengggunaan trawl dan pengamatan akustik (semua daerah dalam unit km^2 10^3).]

Subarea	Total shelf	Surveyed area	Shallows to 99 m		100-200 m	
			Trawlable	Untrawlable	Trawlable	Untrawlable
3	40	20.5	10.0	2	2.5	6
4	18	13.0	5.0	1	2.0	5
5	1	13.5	4.5	2	1.0	6
6	13	12.0	4.5	1	1.5	5
7	12	11.0	4.0	1	2.0	4
Σ	84	70.0	28.0	7	9.0	26

Table 3. Average total catch per effort ($\bar{x}$) of bottom trawl, by area, depth and season (in $kg \cdot hour^{-1}$).

[Tabel 3. Ringkasan hasil tangkapan total per upaya dari trawl dasar (kg per jam) berdasarkan daerah, kedalaman dan musim.]

Sub-area	Depth (m)	NW monsoon (November-February)			Intermonsoon I (March-April)			SE monsoon (May-September)			Intermonsoon II (October)		
		n	$\bar{x}$	s.d.	n	$\bar{x}$	s.d.	n	$\bar{x}$	s.d.	n	$\bar{x}$	s.d.
	0-49	1	220	-	18	315	159	7	434	543	-	-	-
	50-99	7	171	57	28	164	122	8	175	140	-	-	-
3	100-149	-	-	-	3	71	40	-	-	-	-	-	-
	150-199	-	-	-	-	-	-	1	241	-	-	-	-
	200+	-	-	-	3	74	133	2	506	345	-	-	-
	0-49	-	-	-	7	658	484	6	246	151	-	-	-
	50-99	-	-	-	5	109	81	6	179	140	-	-	-
4	100-149	-	-	-	-	-	-	1	31	-	-	-	-
	150-199	3	71	13	-	-	-	3	54	41	-	-	-
	200+	3	127	110	2	100	111	2	241	151	-	-	-
	0-49	9	203	218	-	-	-	10	326	326	5	195	128
	50-99	3	463	96	-	-	-	9	180	221	2	96	56
5	100-149	1	608	-	-	-	-	4	94	104	-	-	-
	150-199	2	441	283	-	-	-	2	233	137	-	-	-
	200+	1	759	-	-	-	-	2	64	66	-	-	-
	0-49	7	1,161	1,346	-	-	-	17	275	155	-	-	-
	50-99	11	301	318	-	-	-	27	307	392	-	-	-
6	100-149	1	394	-	-	-	-	23	145	117	-	-	-
	150-199	5	204	129	-	-	-	-	-	-	1	83	-
	200+	1	155	-	-	-	-	-	-	-	-	-	-
	0-49	4	625	796	12	311	368	6	1,208	1,369	-	-	-
	50-99	10	18	735	397	475	309	11	509	386	-	-	-
7	100-149	7	1,496	1,289	16	265	281	-	-	-	-	-	-
	150-199	6	397	207	11	270	197	2	316	247	-	-	-
	200+	11	360	242	19	281	140	1	228	-	-	-	-
Σ	-	77	-	-	158	-	-	150	-	-	16	-	-

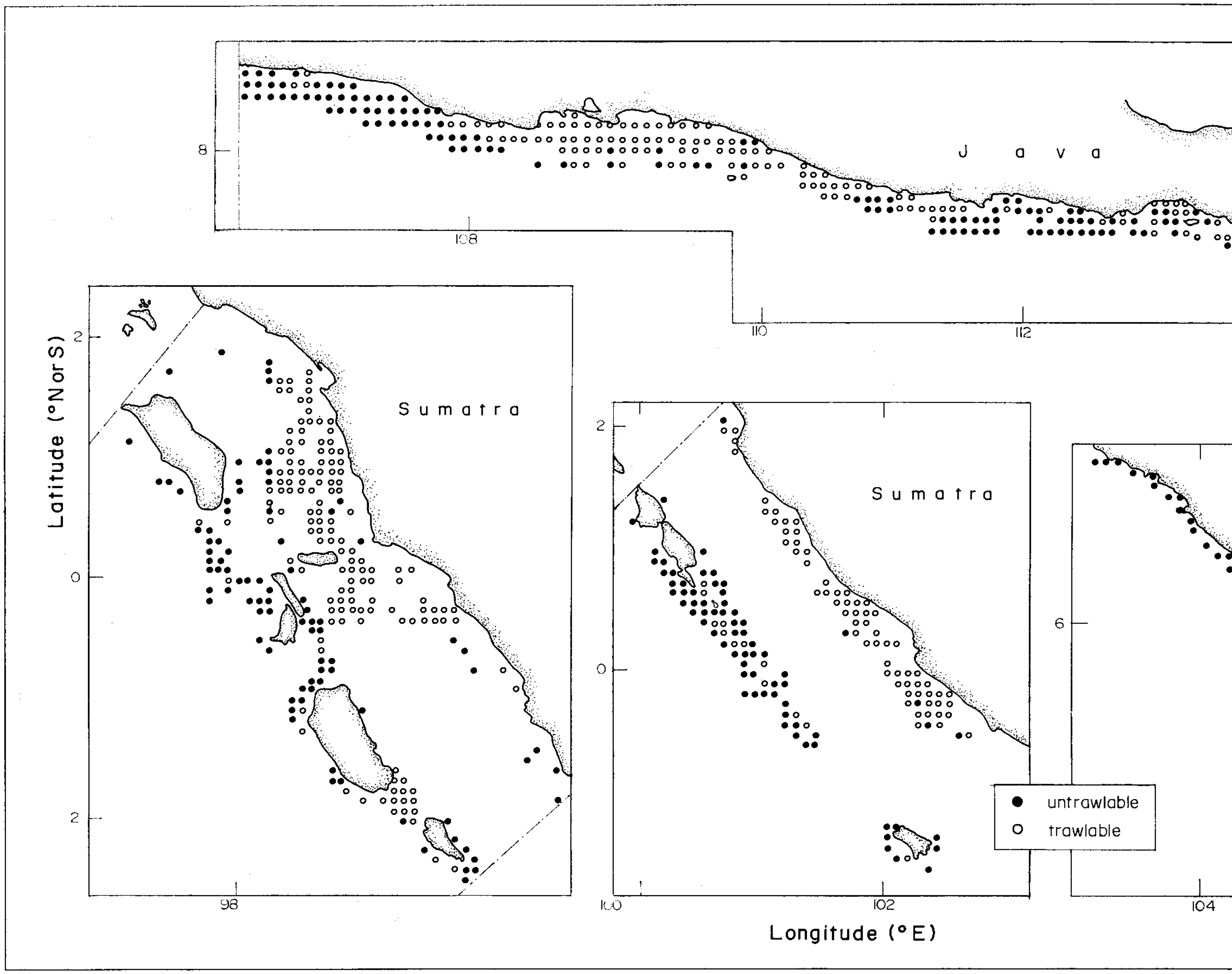


Fig. 7. Showing the distribution of smooth (trawlable) and rough (untrawlable) grounds, as assessed from echosounding records and bottom trawling dur
[Gambar 7. Penyebaran dasar perairan yang layak dan tak layak untuk operasi trawl berdasarkan pengamatan echosounding dan operasi trawl dasar se

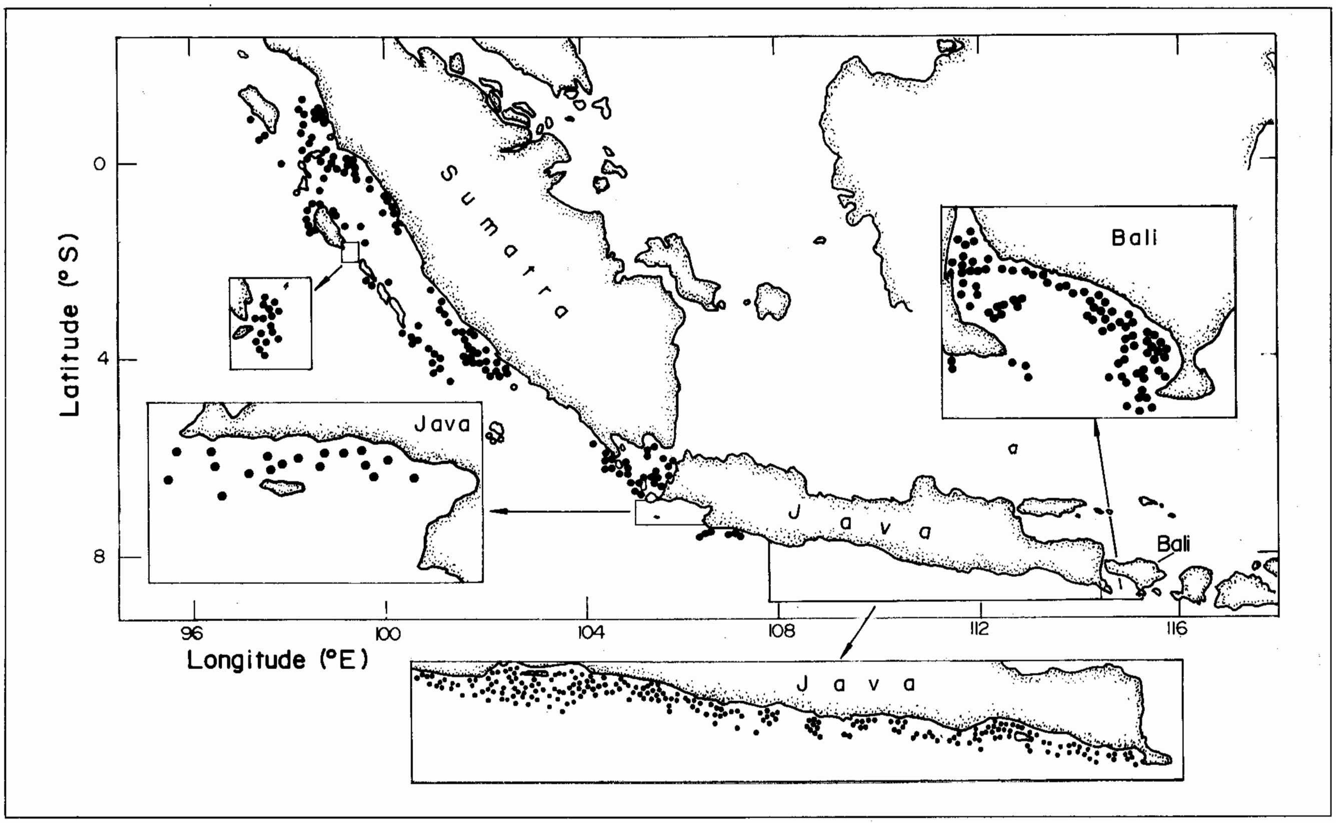


Fig. 8. Bottom trawl stations covered in Module II of JETINDOFISH, from August 1979 to July 1981.
[Gambar 8. Penyebaran stasiun trawl dasar yang diliput selama JETINDOFISH Modul II, dari Agustus 1979 hingga Juli 1981.]

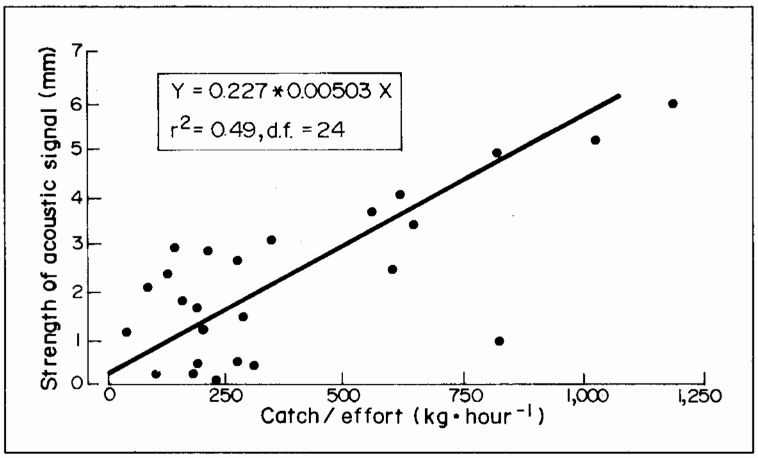


Fig. 9. Relationship between demersal trawl abundances estimates through bottom trawling (in kg·hour^{-1}) and acoustics (mm deflection of integrator). Based on records from locations where both measures could be unequivocally related to each other.
[Gambar 9. Hubungan antara penunjuk kelimpahan sumberdaya ikan demersal (kg/jam) berdasarkan pengamatan trawl dasar dan pengamatan akustik (mm defleksi dari integrator), sesuai dengan catatan pengamatan dari stasiun-stasiun dimana kedua parameter sangat berkaitan satu sama lain.]

Box 5. Lobsters and deep sea shrimps.
[Boks 5. Udang barong dan udang laut dalam.]

Bottom trawling is not a good method for aimed fishing of palinurid lobsters, which generally hide in the crevices of rocky areas during daytime, from which they emerge to forage at night.

Still, adult spiny lobsters occurred in 6% of all successful trawl catches, notably 26 individuals from a depth of 211 m off Central Java, and 12.5 kg·hour^{-1} at a depth of 320 in the Bali Strait.

The depth preference of spiny lobsters is illustrated by the following:

Trawling depth (m)	Number of valid hauls	Hauls with adult palinurid (%)
0-49	340	7 (2)
100-199	97	8 (8)
200+	78	16 (21)

Phyllosoma larvae were occasionally observed clinging to the trawl net and the locations where this occurred generally corresponded to those areas where adults were caught.

Shovelnose lobsters (*Thenus* sp.) were caught in 35 bottom trawl hauls; only at three of these stations were they taken together with spiny lobsters.

In constrast to spiny lobster, most shovelnose lobsters were caught in shallow waters, i.e., in nearly 50% of all stations down to 49 m, 20% of those between 50 and 99 m, and in less than 5% of the deeper stations.

Unidentified deep sea shrimps (*Solenocera*?) were caught in 160 of the valid bottom trawl hauls, with the highest concentration (28 to 108 kg· hour^{-1}) occurring along the southern coast of Central Java, at depths of 180-290 m.

coastal areas range from sandy to sandy-muddy. The western shelf of the Java Island is very narrow, rocky, and scarred by ravines. These conditions make trawl fisheries almost impossible.

The sea bottom to the south of Central Java is an extended shelf with a substratum that is predominantly muddy. The shelf in front of the East Java coast is generally about 4 nm wide, and the bottom usually rocky; wherever the sea bottom is level, it is almost always muddy-sandy. The adjacent Bali Strait has a predominantly shallow, sandy bottom; whereas south of Bali, the shelf is very rocky and with a rugged structure. The continental slope is generally very steep with ravines perpendicular to the coastline. Fishing with a bottom trawl is possible only in few selected places. Fig. 7 and Table 2 summarize these findings.

Fig. 8 shows the distribution of bottom trawl hauls by *FRV*

Jurong during the survey area, and Table 3 presents the corresponding mean catch rates, by area, depth and season.

Fig. 9 shows the relationship between trawl catch rates and the corresponding acoustic estimates of density. The (geometric mean) regression line (Ricker 1973) shows a reasonably good fit ($r = 0.70$; $P < 0.01$), suggesting that the acoustic estimates do reflect relative densities, and thus allow conversion of acoustic density estimates into (rough) estimates of catch/hour and *vice versa*.

The biomasses estimated for the entire shelf area covered by Module II were 140,000 t for area 3; 43,000 t for area 4; 62,000 t for area 5; 69,000 t for area 6 and 97,000 t for area 7 (areas 1 and 2 were not surveyed).

The final survey report submitted by the project team to the DGF (Lohmeyer 1982) presented, beyond those recalled here, detailed tables with catch/hour data for various commercial categories of fish, and estimates of potential yield (P_y) based on the Gulland equation of 1971, i.e., $P_y = 0.5 \cdot M \cdot B_o$, where with our biomass estimates serving as unexploited stock sizes (B_o) and "M" set at 1 year^{-1}.

This material is not presented here: we now know that the equation of Gulland (1971) does not predict *sustainable* yields (Beddington and Cooke 1983), and this also invalidates our initial estimates of potential yields for various groups of commercial fish.

I refer instead to McManus (this vol.) who presents community analyses based on the data we sampled, and to Pauly et al. (this vol.), who discuss the biology, distribution and abundance of various fish groups throughout Western Indonesia, based on data collected during *FRV Jurong's* and other trawl surveys (and see Box 5 for notes on large crustaceans).

Finally, I wish to draw the reader's attention to the contribution of Torres et al. (this vol.), which documents the (MS-DOS) computer files containing most of the data we gathered, including the trawl catches, haul-by-haul and species-by-species. These data are available to anyone interested in their further analysis.

Such (re)analysis would be to the credit of all those who participated in Module II of JETINDOFISH.

Acknowledgements

I would like to thank Drs. Jürgen Saeger and Daniel Pauly for extracting the above summary from my earlier accounts of Module II of JETINDOFISH (Lohmeyer 1982, 1987); also if belatedly *Terima kasih* and *Danke schön* to all the Indonesian and German colleagues who contributed to this project.

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Marine Bottomfish Communities from the Indian Ocean Coast of Bali to Mid-Sumatra[a]

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McMANUS, J.W. 1996. Marine bottomfish communities from the Indian Ocean coast of Bali to mid-Sumatra *[Komunitas ikan dasar di perairan pantai Samudra Hindia dari Bali hingga pertengahan Sumatra]*, p. 91-101. *In* D. Pauly and P. Martosubroto (eds.) Baseline studies of biodiversity: the fish resources of Western Indonesia. ICLARM Stud. Rev. 23, 312 p.

Abstract

The fish communities of Bali to mid-Sumatra region are characterized by an assemblage extending reasonably uniformly across all depths overlain by a shallow fish community of more mobile species which tapers off sharply at approximately 100 m depth. The physical explanation for this limitation is not clear, but behavioral adaptations to periodic oxygen limitations cannot be discounted. Both the shallow and depth-ubiquitous communities can be subdivided further, but the resulting assemblages exhibit high between-group similarities. The shallow assemblages are both species-rich and highly even in distribution of biomass among species. The ubiquitous assemblages are relatively species-poor and exhibit low evenness. The waters below 100 m could probably be fished by commercial interests without substantially affecting the fish communities in shallow waters and vice-versa, but the low biomass of fish below 100 m probably makes this impractical.

Abstrak

Komunitas ikan dari Bali hingga daerah pertengahan Sumatra ditandai dengan suatu assosiasi kelompok yang tersebar secara seragam di semua kedalaman dan ditandai dengan komunitas ikan daerah dangkal yang merupakan spesies yang aktif bergerak dimana secara berangsur-angsur berkurang kelimpahannya secara tajam pada kedalaman sekitar 100 m. Keterbatasan secara fisik tidak jelas, namun perilaku adaptasi terhadap keterbatasan oksigen tidak boleh diabaikan. Baik komunitas laut dangkal maupun komunitas yang tersebar merata berdasarkan kedalaman dapat diperinci lagi lebih lanjut, namun demikian kelompok pembagian yang dihasilkan menunjukkan persamaan antar grup yang tajam. Kelompok laut dangkal pada umumnya kaya akan spesies dan mempunyai penyebaran biomasa yang merata antar spesies. Kelompok yang tersebar merata pada semua kedalaman umumnya miskin akan spesies dan penyebarannya kurang merata. Kegiatan penangkapan pada kedalaman lebih dari 100 m dapat dilaksanakan tanpa mempengaruhi perairan wilayah dangkal, demikian pula sebaliknya, namun rendahnya biomassa sumberdaya perikanan pada perairan kedalaman dibawah 100 m, menyebabkan kegiatan penangkapan ikan menjadi tidak praktis dilakukan.

Introduction

Trawl fishing grounds are often heterogeneous environments consisting of a variety of identifiable habitats and their associated species assemblages. An important step toward informed management of such grounds is the identification of these species-habitat combinations. Species which tend to cooccur, the "recurrent groups" of Fager and Longhurst (1968), can serve as fundamental fishery management units, or Assemblage Production Units (APU - Tyler et al. 1982). Indeed, models have shown that efforts to optimally harvest a diverse assemblage of species with different production capabilities as a single, combined unit will tend to lead to a reduction in the number of species contributing to production. Such an imposed shift in the relative abundances among species may not necessarily be reversible upon reduction of fishing effort (Tyler et al. 1982; Beddington 1984). Ralston and Polovina (1982) showed that production models analyzed for a heterogeneous demersal fishery as a whole may be less informative and useful than similar models applied individually to groups of species identified by cluster analysis. Finally, it has been suggested that site-species groupings may be used as a basis for dividing a fishery between competing fishing interests, such as between large-scale commercial trawling and small-scale fishing (McManus 1985a). In this case, the boundaries between species distributions can be treated as "ultimate stock boundaries", and optimally chosen lines dividing areas containing different sets of species can potentially be used to regulate fisheries on a geographic basis.

Southeast Asian waters form a biogeographic unit of high diversity (the highest marine diversity globally), with strong

[a]ICLARM Contribution No. 1121.

affinities to communities throughout the Indian Ocean (McManus 1985b, 1993). Previous classificatory studies of demersal fish communities of these two regions include McManus (1985a, 1986, 1989), Bianchi (1992), Bianchi et al. (this vol.) and Federizon (1992). Other studies are summarized in Longhurst and Pauly (1987). The study of McManus (1985a, 1986) involved analyses of published data from 15 trawl surveys made at the same 28 sites in the Samar Sea (Philippines) over 1.5 years. This division involved principally species within genera, and only some families (e.g., Nemipteridae) were restricted by the line. The study demonstrated that a major feature of the community, a division at approximately 40 m depth, was a stable feature throughout the period and hence not affected by seasonality. This helped to substantiate the usefulness of community structural analysis methods originally designed for stationary land plant communities in analyses of communities of highly mobile fish. However, the sites sampled were primarily shallower than 100 m. A preliminary study of the data from the JETINDOFISH survey from the Indian Ocean side of Indonesia (McManus 1989) showed that a far more substantial division existed at approximately 100 m, involving several tens of families and hundreds of species which did not extend deeper than this. Subsequently, Federizon (1992) demonstrated that a 100-m division occurred in the Ragay Gulf of the Philippines as well, a preliminary indication that the division may be a widespread phenomenon. Bianchi's (1992) studies of research trawl data from the western Indian Ocean (Pakistan, Oman, Yemen, Ethiopia and Somalia) indicated a tendency for many fish species to shift location in order to avoid seasonal oxygen depletions. This was particularly apparent in areas of seasonal upwelling, and depth-based community structure could be expected to be far more stable in nonupwelling areas, such as the eastern Indian Ocean. Bianchi (this vol.) analyzed research trawl data from the northwest Sumatra, and found a community break at 40 m quite similar to that found in the Samar Sea (McManus 1985a, 1986). That study again included few samples below 100 m.

The current study is a more complete analysis of the JETINDOFISH data aimed at elucidating the trends identified in the preliminary analysis (McManus 1989). In particular, the study emphasizes the grouping of sites and species by co-occurrence so as to facilitate the management of this extensive fishery, as well as the future investigation of the specific ecological and evolutionary causes of the depth limitation.

Methods

The study area (Fig. 1) was described by Lohmeyer (this vol.), who provided a description of the trawls, tracks and other useful information; the material discussed here was gathered through over 860 research trawl hauls made from 1979 to 1981. For this study, hauls which were more than 10 m above bottom at their start or finish were omitted, as were hauls for which no fish families were identified. This left 534 trawls for analysis. This being an awkwardly large number of objects to display and interpret effectively in a classification analysis, it was decided to average the species abundances found within each area and each 10 m depth zone. This left 119 area-depth groupings or "sites" (Table 1). The data on numbers of fish were incomplete or inaccurate in many cases (e.g., 20 kg, 0 individuals), reflecting the focus of the research program on locating large biomasses of trawlable fish rather than on determining community structural properties. Bianchi (1992) showed that when dealing with large-scale gradients and heterogeneous assemblages, results from fish weight vs. fish number analyses differ only slightly. Thus, the present analyses concentrated on analyses of catch weights standardized to kg km^{-1}.

The JETINDOFISH Project was extensive in scope, involving several taxonomists identifying species from a poorly known region. Data were copied from form to form and keypunched into mainframe computers, and later re-entered into a microcomputer manually after copying from printout summaries (after archived tapes became potentially unreadable). The resulting list of 9,723 species catch records contained 1,286 "species", including some identified only by a code and others known to family, genus or species level. The latter species names involved some misspellings. However, most of the names needed taxonomic updating. This was done for finfish using an automatic synonymy program (see Froese

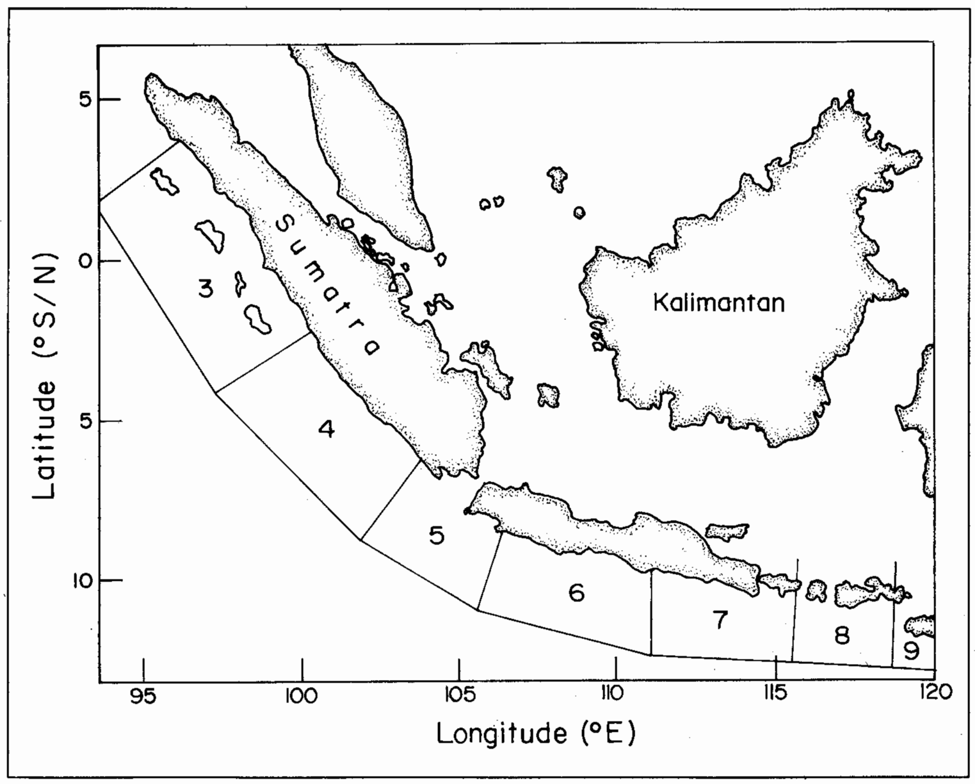

Fig. 1. Map showing the trawl areas for the JETINDOFISH survey. Areas 1 and 2 were not surveyed. *[Gambar 1. Peta yang menunjukkan daerah trawl untuk survei JETINDOFISH. Tidak ada survei yang dilakukan di daerah 1 dan 2.]*

Table 1. Sample distribution chart. The numbers represent the number of hauls averaged within each area - depth class to give the average catch rates per species for each "site". Blank boxes are those for which no data were available.

[Tabel 1. Peta distribusi contoh. Angka menunjukkan jumlah tarikan rata-rata di tiap daerah dan kelompok kedalaman untuk memperoleh rata-rata hasil tangkapan per jam berdasarkan spesies di setiap daerah. Kotak yang tidak ada angkanya menunjukkan ketidaktersediaan data.]

Depth (m)	Area A3	A4	A5	A6	A7	A8	A9
10	-	3	-	-	1	2	-
20	6	1	3	3	2	13	1
30	8	7	10	10	5	16	7
40	9	7	8	10	15	32	8
50	4	4	4	17	12	26	1
60	10	5	5	6	8	19	2
70	8	5	3	5	14	9	1
80	6	9	2	5	6	5	-
90	2	-	2	5	2	-	-
100	1	-	-	13	1	1	-
110	-	1	1	10	2	-	-
120	1	-	1	2	3	-	-
130	-	-	1	-	1	2	-
140	-	-	1	-	3	4	-
150	-	-	-	1	3	1	-
160	-	1	-	-	1	-	-
170	-	1	2	2	2	-	-
180	-	2	-	3	4	-	-
190	1	3	2	2	2	-	-
200	-	2	-	1	5	-	-
210	-	-	2	-	2	-	-
220	-	2	-	-	2	-	-
230	1	1	-	-	4	1	-
240	-	1	-	2	2	1	-
250	-	-	-	-	4	-	-
260	1	-	-	1	2	-	-
270	-	-	1	-	3	-	-
280	-	1	-	1	5	-	-
290	-	-	-	1	1	-	-
300	-	1	-	-	-	-	-
320	-	-	-	1	-	-	-
330	1	-	-	-	-	-	-

et al., this vol.) which matched up the survey names with the list of over 60,000 synonymies in FishBase 96 and suggested corrections. The resulting corrected list of names contained many within-survey synonymies, reducing the total species list in the survey (including species not fully identified, as well as harvested cephalopods and crustaceans) to 703 species. The availability of this procedure greatly enhanced the accuracy of this study, and may be considered a significant step toward enabling more thorough comparative analyses of research trawl data from around the world in the future (see also Pauly, this vol.).

The data were classified into species-site groups using two-way indicator species analysis (TWIA - see Box 1 and Bianchi, this vol.). For this purpose, a microcomputer version of the original TWINSPAN program (Hill 1979) was recompiled to be able to handle 400 species (with 119 sites), the maximum possible on the existing microcomputer system available. Thus, the data matrix was converted from the Microsoft Access database format to Microsoft Excel spreadsheet format, and reduced to the 400 most abundant species by weight before conversion (using a new macro in Visual Basic for Microsoft Excel) to the compressed data format required by TWINSPAN.

Box 1. Two-way indicator species analysis (TWIA).

[Boks 1. Analisis spesies berdasarkan indikator dua arah (TWIA).]

TWIA is a method for rearranging tables of species abundances by site and dividing the table into distinct sets of similar species (based on where they are found in what abundance) and similar sites (based on what species are found in them in what abundance). A successful classification yields data arranged in clear blocks within the table. In the early days of plant community ecology ("phytosociology"), such tables were created by tediously rearranging raw data tables by hand, with repetitive cutting and pasting of columns and rows. The TWIA approach, embodied in the TWINSPAN program of M.O. Hill (1979) revolutionized the field by automating the procedure.

TWIA begins by turning a table of abundances into a table of presence-absence values. This is accomplished by requiring an initial coding of all data into single digit integer values, such as a 1-5 semiquantitative scale. A species x with a maximum value of 3 in a row, becomes species x1, x2 and x3, each with a maximum value of 1 in any column. The program then arranges the sites (columns) of a table based on the scores of each site on the first axis of a reciprocal averaging (basically correspondence analysis) ordination axis. This procedure groups similar sites together and lines them up along the axis representing the greatest variance among both sites and species taken simultaneously. The program then attempts to divide the table into left and right portions from the center of the columns. It analyzes the effect of this split in terms of how well the abundances of each species are clumped onto one side or the other of the division. It tries several such divisions, cutting left and right of the center, each time tallying up a score based on how well the species abundances are divided up. It then chooses the best division, and this becomes the highest level division of the classification. The program now repeats the ordination for only those sites (columns) on the left of the division, to find a good arrangement and division of this subset of columns. Then it does the same on the right of the first division. Now there are four classes of sites, as indicated by two levels of division. A third level of division would yield eight classes of sites, and so on. This is the basic procedure, although the program contains corrections and adjustments for rare species weightings, etc., which can be manipulated in the analysis.

Next, the program classifies the species (rows) in a manner similar to that of the sites (columns). Once the species classification has been completed, the program switches around the species (keeping the species groups intact) in such a way that the table is in an optimal "block" form, with blocks of high species abundances arranged along one or the other diagonal of the table. The table is then converted back to the integer values, and printed along with indications of the hierarchy of site and species divisions. Additionally, the program indicates what species are particularly good indicators of any site division, and helps to identify "border" species of uncertain position in a division of sites.

The method has the advantage over most agglomerative classifications that it is very easy in the end to explain *why* a particular set of sites or species were grouped together. This is generally obvious from studying the output table. As a divisive "top-down" approach, the method also avoids the problem of "chaining", i.e. the tendency for a single class in agglomerative "bottom-up" clustering to grow like a snowball, gathering new characteristics as it does, and thus obscuring the inherent structure of the data set. However, TWINSPAN does not always provide clear one-to-one matching between site and species groups, e.g., there may be eight site groups but only six species groups due to failed divisions (based on various criteria for failure that the program uses). Even equal numbers of site and species groups may not match up well, such that the third group of sites may not correspond to the third group of species. This is because the method does not perform the two-way analyses simultaneously. Finally, there is no way to determine the probability that a given division could have been achieved by the mere fact that the matrix was sparse (containing lots of zero values) and patchy to begin with. Nonetheless, TWINSPAN is the most widely used program of its type currently available.

The top 400 species represented 98% of the total weight of fish (after standardization to kg km^{-1}). The effort to include as many species as possible was necessary because many of the deeper water samples were dominated by species which were ranked very low in total catch weight in the overall study,

Box 2. Multidimensional scaling analysis (MDA) and other ordination methods.
[Boks 2. Analisis skala multidimensi (MDA) dan cara ordinasi yang lain.]

MDA is a method for ordinating multidimensional data, i.e., displaying the data (e.g., sites based on similarities among species abundances) on a few (often 1, 2 or 3) axes in a graph. The fundamental problem is that one cannot do so without distorting the data. For example, one cannot project the Earth onto a two-dimensional map without altering the appearances of the continents — this is why there are so many different kinds of map projections available. The most common ordination method, principal components analysis (PCA), works by rotating an axis into such a direction in the multidimensional cloud of points (e.g., sites), until the projection of those sites onto the axis explains the greatest possible variance ("spreads out" the points the best). This becomes the principal axis. The second axis is limited to being at right angles to the first, but rotated through the dimensions until it explains most of the residual variance. A third, fourth and fifth axis can be constructed accordingly, but this is difficult to see in one's mind's eye. The data cloud then projected onto those axes and plotted on a piece of paper then represents the most of the variance in the data cloud possible in a two-dimensional picture.

Correspondence analysis (CA) and the nearly identical reciprocal averaging (RA) work similarly to PCA. However, the final axes are not rotated to account simply for the variance of the sites or species, but rather to account for each relative to the other. The final graph can include both species and sites on the same plane, something which is not possible in simple PCA.

MDS differs from these methods in that the objective is more clearly to display the data in a given set of dimensions with as little distortion as possible. Thus, there is no rotation of axes. Rather, the data are shifted into place in an algorithm that minimizes the distortion in the distances between the points as it proceeds. Mathematically, this involves the creation of a distance matrix, and in this study the data were transformed to ln(x+1) to minimize effects of spurious abundances, and then converted to a Euclidean distance matrix for analysis. As with PCA, a major portion of the variance tends to be associated with the first axis (although not in such an "intentional manner"), and thus it is reasonable to plot the sites based on the first axis coordinates against environmental parameter values such as depth.

PCA is particularly problematic when dealing with nonlinearly related points, such as sites related by species abundances. Both PCA and MDS tend to form arches where one would expect straight lines reflecting known gradients. CA also arches, but less so, and avoids problems such as inversion of points at ends of a gradient. The arch can even be minimized through "detrending" (see Bianchi, this vol.). Thus CA or detrended CA (DCA) is preferred by many ecologists. Other ecologists prefer MDS because of its philosophical orientation (minimizing distortion). Still others prefer to use both, so as to check that results are robust, i.e., not an artifact of a particular method. In the end, the choice may be simply one depending on the availability of working, reliable software, as was the case in this study.

due to the relatively much higher biomasses encountered in the species-rich shallow waters. The data were analyzed using the default settings of the program except for the levels of hierarchical analysis, which were set to three. The default cut values (upper limits of 1, 2, 5, 10 and 20+ kg/km scaled to values 1 - 5, respectively) were used as they produced a reasonable distribution of values in the output table.

A graphical analysis of the relationships among sites was accomplished using multidimensional scaling (Norkis 1993, and see Box 2). The SPSS for Windows Version 5.0 software imposed a limit of 100 objects on the analysis. Thus, it was necessary to remove the least abundant 19 sites from the analysis. The top 100 sites used represented 98% of the total catch-weight. Data (x) were converted to ln(x+1) before MDS analysis to minimize the effects of spuriously high abundances from chance encounters with large schools. The sites were identified as to groupings from TWIA (group H, consisting of a single site, was removed in the processing). The primary MDS axis was plotted against depth to highlight the relationships between the TWIA groupings and depth.

Finally, the mean kg km^{-1} values of each species by depth were tabulated for the top 50 species. These were converted to ln(x+1) values and then sorted by "center of gravity" (mean depth after weighting by abundance). The values were then plotted in stacked histograms representing the gradual shift in species structure as one proceeds from shallow to deeper waters.

Results

The TWIA output is shown in Table 2. Each column represents a "site" (average standardized haul within an area and a 10 m depth group - designated such that "20" means 10+ to 20 m). The area (3-9) is indicated at the top of each column. The site group identified by TWIA follows, as indicated by a dash or letter. The depth group is indicated as two or three digits arranged vertically (the first column is "140"). Each row of the table represents a species, either by name or code. Species identified by TWIA as indicators of a final site group (A-F) are marked accordingly (only lower hierarchical divisions are considered for simplicity). In the table, a dash indicates a zero value. The values 1-5 represent upper class limits of 1, 2, 5, 10 and 20+ kg km^{-1}, respectively. Only the top 100 species are displayed, although the analysis involved 400 species.

The table shows a very clear division, wherein groups E, F, G and H include most of the sites below 100 m. Groups A and H appear to contain sites at intermediate depths around 100 m. The MDS graph shows that most of the deep sites cluster tightly relative to the shallow sites, an indication of relatively little variability in the deeper assemblages (Fig. 2). The plot of the primary MDS axis against depth clearly shows the restriction of groups B and C to waters above 100 m (Fig. 3). Groups B and C differ only in relative dominances by fairly similar species, as do groups E and F. The hierarchical relationships are shown in Fig. 4, and support these relationships. The top ten species of each group are listed in Table 3. The TWIA table shows that the shallow sites included most of the species which dominated the deep sites. However, these species were reduced to lower significance in the shallow sites by the presence of large biomasses of the shallow preferential species. Thus, the community was apparently a combination of an ubiquitous assemblage of lizardfish (e.g. *Saurida undosquamis*), bigeyes (e.g., *Priacanthus macracanthus*) and others, overlain by a shallow-water restricted assemblage of leiognathids, lutjanids and many others. This is supported further by the histograms of individual species against depth (Fig. 5).

An inspection of the site groups indicates that Group B, dominated by *Dasyatis* sp., *Leiognathus equulus* and others, is a shallow-water assemblage characteristic of areas 8 and 9, and to a lesser extent, 3. Group C, dominated by *Sardinella*

Table 2. TWIA output table, modified for clarity. Each column represents a single site. Dashes represent no occurrence of a species in a site. Values are
shown as vertical numbers (e.g., 140 for the first column). Other details may be found in the text.
[Tabel 2. Tabel output TWIA, dimodifikasi untuk memperoleh kejelasan. Setiap kolom mewakili satu daerah. Tanda kosong menunjukkan tidak tertangkap
menunjukkan kelimpahan relatif. Kelompok kedalaman ditunjukkan sebagai angka-angka vertikal (misalnya: 140 pada kolom pertama). Rincian lain dapa

Indicator	Species	Family	General	A	B	C / D	E
			Area	8693	8898883385899335443483484593595	777737567656465656764667644	6677768466474
			Site Group	A	B	C / D	E
			Depth Group	11 1	1 1 1	1 1	2112122222222
				4250	4345623286736687857615607229879	674543388047365921144352212	9999744468368
				0000	0000000000000000000000000000000	000000000000000000000000000	0000000000000
	100362		Finfish	----	5------------------------------	---------------------------	-------------
B,C	*Lutjanus malabaricus*	Lutjanidae	Finfish	----	4344542-545-4432333-13232--11-1	22-23-35--14--55-1---------	-------------
B	*Epinephelus tauvina*	Serranidae	Finfish	----	425443253334333-2-3-212-2--1---	4454221--2421222-----2--1--	-------------
	Naso sp.	Acanthuridae	Finfish	----	3-5222-------2---451----------	-----------1-4-------1-----	-------------
	100365		Finfish	----	5------------------------------	---------------------------	-------------
	Diagramma pictum	Haemulidae	Finfish	----	-3544225-1343-2-12212-1-1----2-	---3-1----1-2--------1-----	-------------
	Lethrinus nebulosus	Lethrinidae	Finfish	----	345252--3-35---------1---------	-5-------------------------	-------------
	Lethrinus variegatus	Lethrinidae	Finfish	----	1-43134-----5---1-14-----------	---------------------1-----	-------------
	Gymnocranius grandoculis	Lethrinidae	Finfish	1--2	21433234112242233122-1121--3-2-	33-1-11---1-1-3------1-----	-------------
	Lethrinus miniatus	Lethrinidae	Finfish	----	--23522---2---2--13--21----2--1	45-4--2---3-3--------1-----	-------------
	Dasyatis kuhlii	Dasyatidae	Ray	----	52245122--11---4--11-------1---	1122--1-1-1-21-------4--3--	-------------
	Carcarhinus sp.	Carangidae	Shark	----	32531-222--3421--3-122---------	----2-------1-------3-----3	-------------
	Aetobatus narinari	Myliobatidae	Ray	----	-5-3---------------------5--4--	----5-15-------------------	-------------
	Lutjanus johnii	Lutjanidae	Finfish	----	35454--------1-----------------	----------1-212----3--1-5--	-------------
B	*Abalistes stellatus*	Balistidae	Finfish	1---	2332223111113-2223121212-3-32111	33221-2---1-2-1-2---1--1---	-------------
	Lutjanus rivulatus	Lutjanidae	Finfish	----	--332-25---4--3-2222-12-1------	33-2-13---2-222------------	-------------
	Parapriacanthus sp.	Priacanthidae	Finfish	----	-----------5-------------------	---------------------------	-------------
	Pristipomoides typus	Lutjanidae	Finfish	----	---12---2-21335-4-2---452--3---	-------2-------------------	-------------
	Aprion virescens	Lutjanidae	Finfish	----	22322-25-13-2-2-2-3-1-1-3-421--	3--2------2-1--------------	-------------
	Acanthurus mata	Acanthuridae	Finfish	----	-35221-----5--4--14-1---1------	----------3--1-------------	-------------
	Stolephorus indicus	Engraulidae	Finfish	----	25---1------------1------------	--------1----------4-------	-------------
	Stolephorus insularis	Engraulidae	Finfish	----	25---1------------1------------	--------1----------4-------	-------------
	Paracaesio sp.	Caesionidae	Finfish	5---	-------------------------------	---------------------------	-------------
	Leiognathus fasciatus	Leiognathidae	Finfish	----	4531---------------------------	------------1------4-------	-------------
	Naso tuberosus	Acanthuridae	Finfish	----	2153124---1------1-------------	---------------------------	-------------
	Lutjanus sanguineus	Lutjanidae	Finfish	----	---------5---5-2------------1-1	2--2------2---5------------	-------------
	Gnathanodon speciosus	Carangidae	Finfish	--3-	51122--12------------2---------	--2-------1-1--------------	-------------
	Saurida micropectoralis	Synodontidae	Finfish	-2--	---3---------------------------	---------------------------	-------------
	Dasyatis sp.	Dasyatidae	Ray	----	-455434155--245545---5-4-------	15--1-54--531-5---3524-----	---3---------
	Gazza minuta	Leiognathidae	Finfish	----	144433----1-5----1--2----------	-----141-12412----51-11--11	-------------
	Himantura uarnak	Dasyatidae	Ray	-55-	----2--------------------------	---------5-----5-----------	-------------
	Selar crumenophthalmus	Carangidae	Finfish	---1	221122--131-231--11-12122---111	12444-42-3135211-2-212211-1	-------------
	100378		Shark	----	----4-----15-2--121---1-3------	--442-------15---2----2----	-1-----------
	Pristipomoides sp.	Lutjanidae	Finfish	5--3	---------1-4----31---------1--1	2-1-3--4-------------------	-------------
	Pomadasys sp.	Haemulidae	Finfish	----	55-2-4-4-------------1---------	-21-5------121-11--2-21----	-------------
	Lutjanus argentimaculatus	Lutjanidae	Finfish	----	---42-3-3----31--12--12-2--1---	3--22-3--32--52---3-43-3--	-------------
	Caranx tille	Carangidae	Finfish	----	3254--1144--24----2-----------1	2--1--11--23-112-1-2--3---	-------------
	Carangoides sp.	Carangidae	Finfish	----	2121312--1-132-4-113111-1-----1	52112----1113312-1--2-21---	-------------
	Mustelus griseus	Triakidae	Shark	----	2--21----2-----------------5---1	1-2------322--1--4---------	-------------
	Stolephorus sp.	Engraulidae	Finfish	----	43-12-33----3------1-----------	----5-2---2-1----1--1-1----	-------------
	Carangoides malabaricus	Carangidae	Finfish	---2	22-11-1112---42--1---2---------	-2--5--1123-1421---11-3---	-------------
	Decapterus maruadsi	Carangidae	Finfish	----	1--11--11-1--3313---1-2----1--	24325----1--------1--------	-------------
	100398		Ray	---1	-------1------444--------------	---4------4--5-------------	-------------
	Drepane punctata	Drepanidae	Finfish	----	254----412--31-----------------	1212131-----11-----1332--11	-------------
	100360		Finfish	----	54-1---1-1-1-------------------	2---------1-----1--31131---	-------------
	Mene maculata	Menidae	Finfish	----	121--5------1-------4---------1	2---1-11-122-11--1--112--1-	-------------
	Leiognathus bindus	Leiognathidae	Finfish	----	5311-55--41-25---2-------------	535545321-5452-2--515-45-24	-------------
	Leiognathus equulus	Leiognathidae	Finfish	----	5551415 5-5--1----1--2---------	45535432-2-332-1--553-43--1	-------------
	Sardinella longiceps	Clupeidae	Finfish	----	1--11------------1-------------	552---1----------------3---	-------------
	Leiognathus sp.	Leiognathidae	Finfish	----	25-11153-1-------11--1-------1--	--554--1-31-3--255--1-2--2-	-------------
	Leiognathus splendens	Leiognathidae	Finfish	----	1----3-----------1-------------	2155155-1-532433---1--2--31	-------------
	Pomadasys argenteus	Haemulidae	Finfish	----	43-1251---------1--------------	45532-3-522222-1-1-3245-431	-------------
	Leiognathus elongatus	Leiognathidae	Finfish	-1--	5--11------1---3-1------1--22-	5-22--512212-----1-----4---	-------------
	100347		Finfish	-1--	51-4-----------------1---------	54-2-------1-1--1----512---	-------------
C	*Pentaprion longimanus*	Gerreidae	Finfish	----	14115131-1---312111--11-1---2-1	5145352-422---31-3--1------	-------------
	Lutjanus sp.	Lutjanidae	Finfish	----	1-3----1-1------111--1--------1	-1-3---5-2--11--5--2-4-----	-------------
	Secutor ruconius	Leingnathidae	Finfish	----	----------------1--3-----------	---------------------5-3---	-------------
	Pomadasys maculatus	Haemulidae	Finfish	----	21115--2----4------------------	45452511421213-----4-34----	-------------
	Lepturacanthus savala	Triehiuridae	Finfish	----	11---1---5--2---------1--------	-5-----2--12-3---1-4-45-5--	------3------
	Sphyraena obtusata	Sphyraenidae	Finfish	----	21132223-11-12--131---1--------	-45-4-511111115-1414-1--41	-------------
	100358		Finfish	----	53-3-1-------------1-----------	-2411-2111-222----45244--1-	-------------
	Ilisha sp.	Clupeidae	Finfish	----	1------2-----------------------	-5-45--1-----------3--532-11	-------------
	Arius thalassinus	Ariidae	Finfish	----	3-1-3-21----32-3-11------------	-3222-11-2242121-2412-35-42	-------------
	Arius sp.	Ariidae	Finfish	----	11-----1-----------------------	13------51---1-2---5-424---	-------------
	Caranx sexfasciatus	Carangidae	Finfish	----	2--2---------------1-----------	--5-------1-1--------1-1--11	-------------
	Pampus argenteus	Stromateidae	Finfish	----	1---------1--------------------	-352-513---112---1-5-333-2-	-------------
C	*Upeneus moluccensis*	Mullidae	Finfish	----	3--1---2-2--13-5112--1--1---2-1	42121-412313--11-2---1-----	-------------
	Lactarius lactarius	Laetariidae	Finfish	----	--1---1------------1-----------	--112-31--11431---513122-21	-------------
	Terapon jarbua	Terapontidae	Finfish	----	11-1--11----11-------1---------	335323-141-3-3-2--4-1131-1-	---------1---
	Leiognathus equulus	Leiognathidae	Finfish	----	-------------------------------	-5-------------------------	-------------
	Aetobatus sp.	Myliobatidae	Ray	----	--------------------2----------	---------5---5-------------	-------------
	Dussumieria acuta	Clupeidae	Finfish	----	-2---1-------------------------	11--4-32--112213-131433-133	-------------
	Dussumieria elopsoides	Clupeidae	Finfish	----	-2---1-------------------------	11--4-32--112213-131433-133	-------------
	Ilisha elongata	Clupeidae	Finfish	----	-------------------------------	------422-54314--1-41-2--21	-------------
	Dussumieria sp.		Finfish	----	------32-----------------------	----5---------------5------	-------------
	Trichiurus lepturus	Triehiuridae	Finfish	----	52---212-----1-1-1-------------	25443422112411111-1551545-31	1----2-----1-
	Upeneus vittatus	Mullidae	Finfish	----	11214-54----13--11-------------	225433133125133--1-2-131--1	-------------

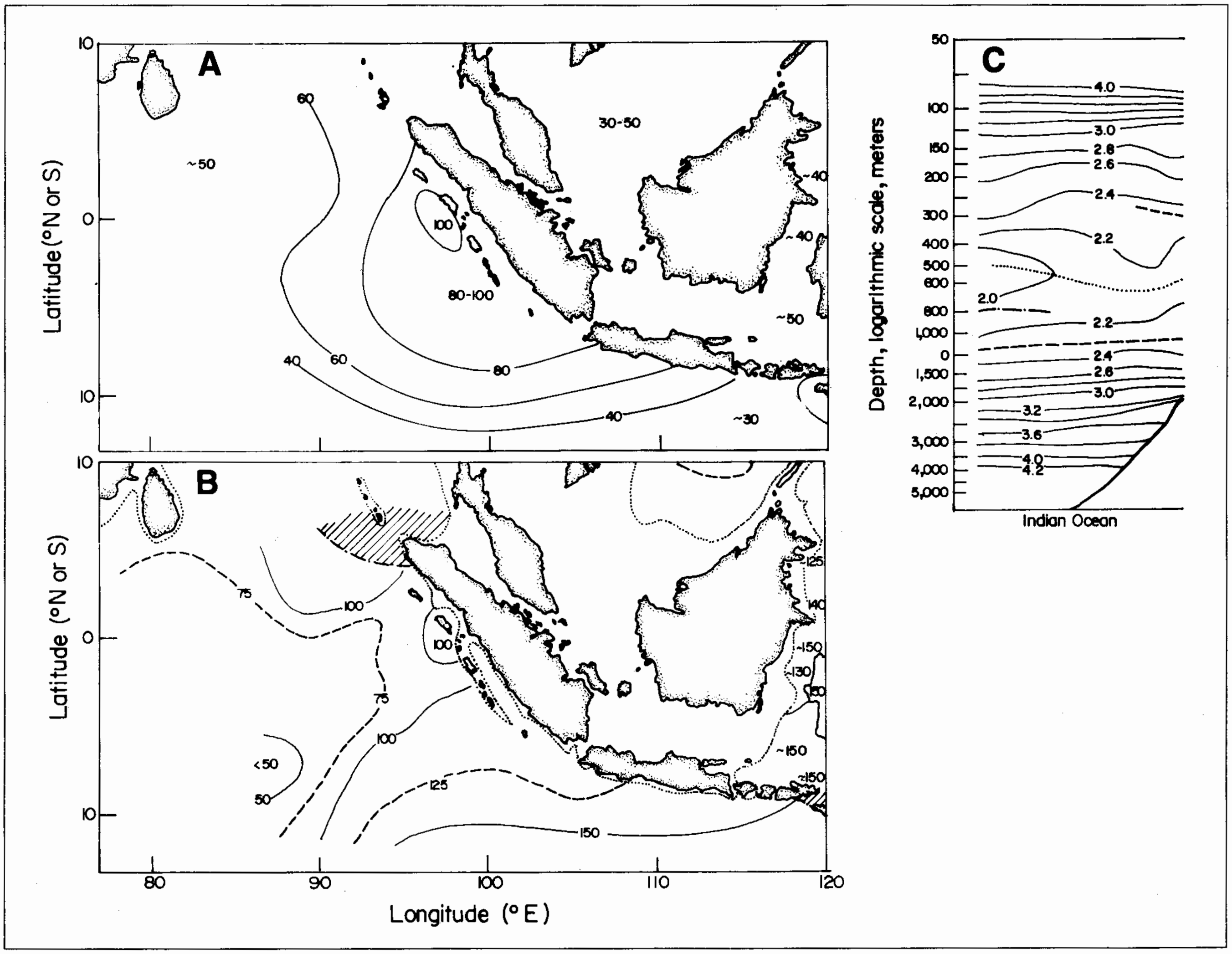

Fig. 7. Some oceanographic features of the study area (after Wyrtki 1961): A. Depth (in m) of the homogeneous layer. B. Depth (in m) of the core layer of the subtropical lower water. C. Oxygen profile (in $ml \cdot l^{-1}$)from the Indian Ocean near Java.

[Gambar 7. Berbagai sifat oseanografis dari daerah studi (menurut Wyrtki 1961): A: Kedalaman (m) dari lapisan yang homogen. B: Kedalaman (m) dari lapisan pokok yang berasal dari perairan subtropik bagian bawah. C: Profil oksigen ($ml \cdot l^{-1}$) dari perairan Samudra Hindia dekat Jawa.]

area experiences seasonal or otherwise periodic or sporadic oxygen depletions with depth, or that the fish are behaviorally adapted to avoiding water masses which have such depletions elsewhere or earlier in geological history, and that they use the water temperature boundary (or accompanying rapid increases in pressure) to delimit their activity accordingly.

Other possible explanations include changes in light levels, productivity and sediment composition. The light limitation would be expected to cause species with differential light requirements to drop away one by one more gradually than is seen. The depth extent of high primary and secondary productivity would be rapidly curtailed below the homogeneous zone, but one might expect the abundances of species to fall off rapidly while still finding these species below this layer. The sediments may indeed change in composition as one progresses from the shelf to the slope at approximately 100 m. However, this sediment change might be expected to affect the synodontids and others as well. Each of these physical explanations remains a possibility for future elucidation. However, at this point it seems likely that behavioral adaptations have sharpened the effect of whatever physical limitation is most influential.

An immediate conclusion from this study would be that commercial trawl fishing below 100 m would not interfere with small-scale fishing in shallower waters, as it would not affect the vast number of species restricted to waters above this depth. While that may be true, such a restriction is unlikely to be practical. As shown in Fig. 8, there is very little biomass to catch below 100 m. This confirms earlier analyses for Southeast Asian waters (Pauly 1987), indicating the futility of planning future expansions into deeper-water fisheries.

The shallow-water assemblages appear to be geographically important rather than being related to depth. Species such as *Leiognathus equulus* and *L. bindus* are desirable target species, and the differences could be related to fishing pressure. Equally, there could be average sediment differences between the lesser Sunda Islands (areas 8 and 9) and the Java to Sumatra region, although the shelves appear to be very heterogeneous (Shepard et al. 1949). The high similarity in species composition between these site groups may be a result of this heterogeneity of bottom types.

Finally, it is noteworthy that the 40-m zonation found by

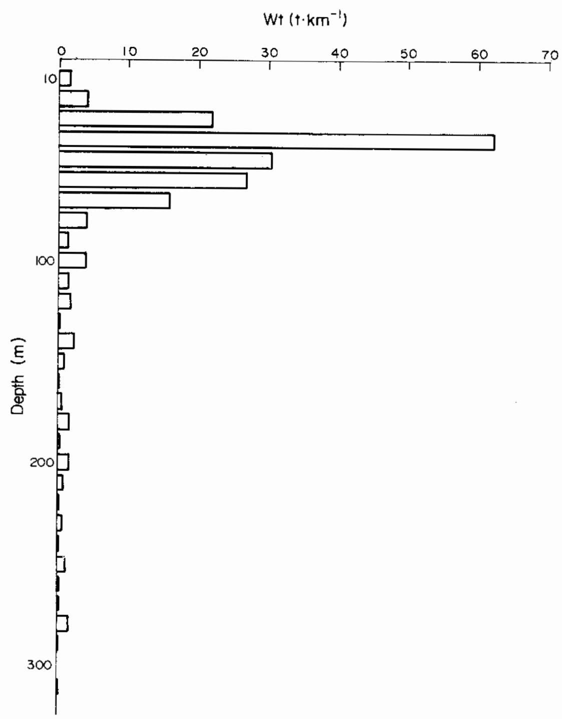

Fig. 8. Depth distribution of catch weights summarized for all sites, reexpressed as standing stock (t·km^{-1}).
[Gambar 8. Sebaran kedalaman dari berat hasil tangkapan yang disarikan dari seluruh daerah pengamatan, dimana satuannya diseragamkan menjadi t·km^{-1}.]

Bianchi (this vol.) in northwestern Sumatra, and by McManus (1985b, 1986) in Samar Sea was not apparent in the present analysis. This could be simply a problem of scale. The area considered in this study was very large, and covered a much greater range of habitat variability relative to the others mentioned. The multivariate methods used are based on the analysis of the total variance of the data matrix used. Thus, the more heterogeneous the data analyzed, the more that finer scale, more subtle patterns are obscured.

Acknowledgements

I would like to thank Dr. Rainer Froese for spending substantial amount of time and effort in helping correct the species names for this study. Ms. Luningning Malumay typed in nearly 10,000 catch records to make this analysis possible. The German Agency for Technical Assistance (GTZ) funded both the original survey and the current analysis. Finally, I would like to thank Dr. Daniel Pauly for helpful discussions and for providing the impetus for this study.

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Results of Surveys for Pelagic Resources in Indonesian Waters with the *R/V Lemuru*, December 1972 to May 1976

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VENEMA, S.C. 1996. Results of surveys for pelagic resources in Indonesian waters with the *R/V Lemuru*, December 1972 to May 1976 *[Hasil survei sumberdaya ikan pelagis di perairan Indonesia dengan kapal penelitian* R/V Lemuru *pada bulan Desember 1972 hingga Mei 1976]*, p. 102-122. *In* D. Pauly and P. Martosubroto (eds.) Baseline studies of biodiversity: the fish resources of Western Indonesia. ICLARM Stud. Rev. 23, 312 p.

Abstract

Results are presented of 48 surveys executed from December 1972 to May 1976 with the purse seiner/trawler *R/V Lemuru* in the Java Sea, Sunda Strait, Bali Strait and coastal areas of the Indian Ocean off Java and the lesser Sunda Islands. Most of this large area was surveyed with a sonar in sweeping mode, looking for concentrations of pelagic fish which were fished by purse seine, often after light attraction. Echosounder records, occasional hauls with bottom and mid-water trawl and catches by trolling lines are also analyzed.

The largely qualitative results of these surveys are compared with the known migration patterns of some important resource species, and with fishing activities at the time of the surveys. The survey results are then related to the subsequent development of pelagic fisheries in the Bali Strait and the Java Sea.

Abstrak

Tulisan ini melaporkan hasil 48 kali survei yang dilaksanakan dengan kapal penelitian multi-guna (purse seine [pukat cincin] dan trawl) Lemuru *di perairan Laut Jawa, Selat Sunda, Selat Bali dan perairan Samudra Hindia di selatan pulau Jawa dan kepulauan Sunda Kecil dalam bulan Desember 1972 hingga bulan Mei 1976. Sebagian besar dari daerah yang luas ini disurvei dengan alat bantu sonar guna mencari konsentrasi ikan yang bergerombol yang kemudian ditangkap dengan jaring purse seine (dan kerap kali dengan kombinasi lampu). Selain itu, ditampilkan pula hasil analisis deteksi echosounders, operasi penangkapan dengan jaring trawl (tengah dan dasar) dan hasil tangkapan pancing tonda*

Hasil survei yang sangat kualitatif ini dibandingkan dengan pola migrasi beberapa spesies ikan penting yang sudah diketahui serta dengan aktivitas penangkapan ikan yang terlihat pada saat survei dilaksanakan. Selanjutnya hasil survei ini dikaitkan dengan perkembangan perikanan pelagis di Selat Bali dan di Laut Jawa.

Introduction

This paper is an abstract of the "Report on the operations and results of the UNDP/FAO vessel *Lemuru* in Indonesian waters, a full account of all fishing operations, echo recordings, observations, cruise tracks and oceanographic data", issued in a limited number of mimeographed copies by the Fisheries Development and Management Project (Venema 1976). It covers data collected from December 1972 to May 1976, during which time R/V *Lemuru* was deployed in eight areas, defined in Fig. 1 (see also Table 1).

In December 1972 *R/V Lemuru* (ex *Sagar Sandhani*) was transferred from Bangladesh, where a war had made its operation impossible, to Indonesia where it was first assigned to a UNDP/FAO Fisheries Development and Training Project based in Tegal, Central Java, and devoted to exploratory fishing and training of crew, then, from April 1973, to the Jakarta-based UNDP/FAO Fisheries Development and Management Project for carrying out resource surveys, led by an FAO biologist (Jones 1976).

From December 1972 until the end of July 1974, *R/V Lemuru* operated from Benoa, Bali, and covered the Bali Strait (Area 7 in Fig. 1), Nusa Tenggara (Area 8), the Indian Ocean south of Java (Area 6), parts of the Java Sea (Areas 1 and 2) and the Sunda Strait (Area 5).

Of this large area, the Bali Strait received most attention, because fishers based at Muncar, East Java, had complained about large fluctuations in the availability of the Bali sardinella (*Sardinella lemuru*)[a], locally called *lemuru*. Data collected during the International Indian Ocean Expedition suggested that an upwelling occurred in the Indian Ocean outside Bali Strait and it was therefore thought likely that the Bali sardinella would form part of a larger resource migrating between the Indian

[a]This was previously known as *Sardinella longiceps* (see Pauly et al., this vol.).

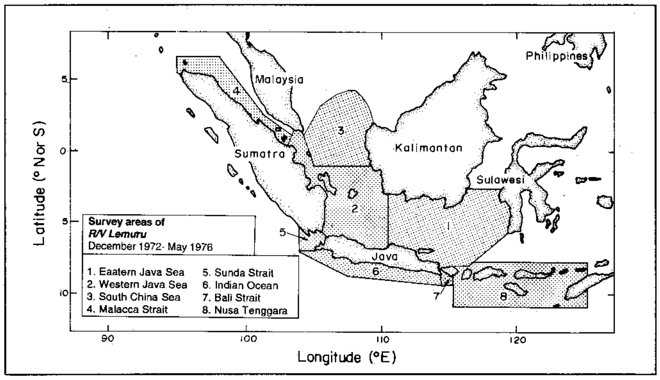

Fig. 1. Map of Western Indonesia, showing the areas surveyed by *R/V Lemuru* from December 1972 to May 1976. *[Gambar 1. Peta Indonesia bagian barat yang menunjukkan daerah yang disurvei oleh kapal penelitian* Lemuru, *Desember 1972 hingga Mei 1976.]*

Table 1. Overview of survey cruises of *R/V Lemuru* in Indonesia, 1972-1976 (total days at sea: 588; see Fig. 1 for definitions of areas covered).
[Tabel 1. Rangkuman pelayaran survei kapal penelitian Lemuru *di Indonesia, 1972-1976 (total 588 hari pelayaran, lihat Gambar 1 untuk keterangan yang diliput).]*

Cruise no.	Dates Start	Finish	Days at sea	Ports Departure	Arrival	Areas covered
7201	3/12	11/12	9	Tanjung Priok	Benoa	2,5,6,7
7202	15/12	20/12	6	Benoa	Benoa	7
7301	29/1	2/2	5	Benoa	Benoa	7
7302	19/2	24/2	6	Benoa	Benoa	7
7303	7/3	12/3	6	Benoa	Benoa	7,8
7304	23/5	4/6	13	Benoa	Benoa	1,7
7305	18/6	2/7	15	Benoa	Tanjung Priok	1,2,7
7306	22/7	31/7	10	Tanjung Priok	Benoa	2,5,6,7
7307	10/8	25/8	16	Benoa	Benoa	6,7
7308	19/9	26/9	8	Benoa	Benoa	7
7309	12/10	1/11	21	Benoa	Benoa	8
7310	8/11	14/11	7	Benoa	Benoa	7
7311	22/11	3/12	12	Benoa	Benoa	6
7312	14/12	21/12	8	Benoa	Benoa	7
7401a	6/1	12/1	7	Benoa	Cilacap	2,5,6
7401b	16/1	20/1	5	Cilacap	Singapore	
7402	10/2	20/2	11	Singapore	Benoa	2,5,6,7
7403	23/2	27/2	5	Benoa	Benoa	7
7404	6/3	1/4	27	Benoa	Benoa	1,7,8
7405	23/4	3/5	11	Benoa	Cilacap	1,6,7
7406	9/5	13/5	5	Cilacap	Tanjung Priok	2,5,6
7407	27/5	12/6	17	Tanjung Priok	Benoa	1,2,5,6,7
7408	22/6	25/6	4	Benoa	Benoa	7
7409	27/6	17/7	21	Benoa	Benoa	8
7410	28/7	2/8	6	Benoa	Cilacap	6,7
7411	6/8	16/8	11	Cilacap	Cilacap	2,5,6
7412	26/8	6/9	12	Cilacap	Tanjung Priok	1,2,6,7
7413	18/9	25/9	8	Tanjung Priok	Semarang	1
7414	30/9	9/10	10	Semarang	Semarang	1
7415	21/10	28/10	8	Semarang	Semarang	1
7416	31/10	10/11	11	Semarang	Semarang	1
7417	17/11	23/11	7	Semarang	Singapore	2
7418	24/12	26/12	3	Singapore	Tanjung Priok	2
7501	8/1	28/1	21	Tanjung Priok	Belawan	2,4
7502	10/2	28/2	19	Belawan	Tanjung Priok	2,3,4
7503	22/3	4/4	14	Tanjung Priok	Semarang	2
7504	17/4	3/5	17	Semarang	Semarang	2,5
7505	17/5	31/5	15	Semarang	Semarang	1
7506	11/6	28/6	18	Semarang	Benoa	1
7507	11/7	27/7	17	Benoa	Semarang	1,7
7508	6/8	22/8	17	Semarang	Semarang	2
7509	3/9	1/10	18	Semarang	Semarang	2,5
7510	10/10	23/10	15	Semarang	Semarang	1
7601a	9/1	13/1	5	Semarang	Semarang	1
7601b	26/1	8/2	14	Semarang	Semarang	
7602	18/2	3/3	15	Semarang	Semarang	2,5
7603	15/3	31/3	17	Semarang	Benoa	1,7
7604	7/4	14/4	8	Benoa	Semarang	1,7
7605	26/4	11/5	16	Tegal	Semarang	2
7606	21/5	31/5	11	Semarang	Semarang	2,5

Ocean and Bali Strait (see also Lohmeyer, this vol.).

The surveys in Nusa Tenggara were intended to provide data needed for fisheries development plans for that area; also, in mid-1974 there was an urgent need for information on the pelagic resources of the Java Sea. Thus, *R/V Lemuru* was transferred to Semarang, Central Java and a series of exploratory fishing surveys were carried out, with emphasis on fish detection and catching aspects.

The arrival of the second FAO biologist (S.C. Venema) in December 1974 coincided with another change in plans: *R/V Lemuru* was to cover the same areas as *R/V Mutiara 4*, viz., the Java Sea (Areas 1 and 2 in Fig. 1), the southern tip of the South China Sea (Area 3), and the Malacca Strait (Area 4) (see Pauly et al., this vol.). However, after only one coverage of the Malacca Straits (see Martosubroto et al., this vol.) and the South China Sea, it was decided to restrict *R/V Lemuru's* area of operation to the Java Sea, with only occasional incursions to the adjacent straits. The cruises were effected in a more systematic way than before, and the acoustic equipment and fishing gear were upgraded to adapt the vessel to its more scientific role. This program was executed successfully until the end of May 1976, when a shortage of funds made it necessary to transfer *R/V Lemuru* to a regional project in the Persian Gulf.

The Vessel and the Surveys

R/V Lemuru was designed as a purse seiner, but trawl gallows were available and bottom trawl hauls were made very frequently, also for food supply on long cruises. Trolling lines were practically always out during daytime. Light attraction was done frequently in suitable areas, mainly during nights with little or no moonlight. Some oceanographic equipment was also

Box 1. Specifications of *R/V Lemuru*, including equipment and gear.
[Boks 1. Spesifikasi kapal Lemuru, *termasuk peralatannya.]*

1. *Principal dimensions* (steel construction)

Length over all	29.35	m
Breadth (moulded)	7.10	m
Depth (moulded)	3.20	m
Designed full load draft	2.55	m
Gross tonnage	165.36	T
Refrigerated fish hold	88	m^3

2. *Engines and deck machinery*

Main engine Caterpillar D 379 - TA 510 Ps Diesel
Auxiliary Cat. D 320 T, 40 KW
Auxiliary Cat. D 330 T, 75 KW
Main winch, hydraulic, high pressure 50 kg/cm^2, approx. 20 tonnes
Hydrographic winch, hydraulic
Boom winch, hydraulic
Boom swinger, hydraulic
Power bloc, hydraulic
Net sounder winch, manual (as of 1976)
Windlass, hydraulic

3. *Electronic equipment*

Navigation:
a. Koden Direction Finder, KS-500
b. Radar 1972-1975 Furuno FR/5/B
c. Radar 1976 Furuno FRM 60 range 64 n.m.
d. Auto pilot Tokyo Keico
e. Compass, Magnetic, Tokyo-Keiki-Seizosho Co. Ltd. (new Dec. 1975)
f. Log, one set taffrail log, without bridge repeater

Radios:
a. Kelvin Hughes Pentland Bravo, Marine Telephone (1974)
b. Radio telephone "Sailor", type 56D
c. Public Addressor, Japan Radio Co. Ltd.
d. Dymar, Marine VHF FM Radiotelephone Type 801A
e. Transistorized Communication Receiver "Eddystone" Model EC - 10 MK. II

Acoustic:
a. Koden Multistylus Fishfinder, removed Dec. 1975
b. Sanken Sonar, Echosounder, Televigraph, model NTLB 3000 A, 20 and 197 kHz, removed in December 1975
c. Sanken Fishfinder New Supergraph NST 300 A, 197 Khz, not in operation during 1976
d. Simrad Skipper Sonar SK 3 (transducer shaft bent during cruise 7307. Repaired and dome installed during overhaul, Jan. 1974)
e. Simrad EQ, 49 kHz, transducer 62 P, installed December 1975
f. Atlas Monograph 58 AN 658, Recorder for net sounder + net sounder installed Dec. 1975
g. Portable echosounder, Furuno, used on skiff

Oceanographic and meteorological equipment
a. 5 Nansen bottles + reversing thermometers
b. 1 Secchi Disc
c. Electronic Thermometer, MS-2, Murayama - Denki Ltd.
d. Compensated Aeorid Barometer. Not calibrated
e. Marine Barometer, Sestrel. Not calibrated
f. Anemometer, Thies Göttingen, 0-30 m/s
g. Forel Scale, Sea color scale

4. *Deck arrangements*

a. Prior to 1975 overhaul: Purse seine covering full aft of deck. Skiff almost at deck level on starboard. Only one (portside) gallow installed.
b. In 1976: Purse seine mainly at starboard side. 2 meters space left at portside. Skiff raised on platform on portside. Second gallow installed, both further forward than before. Midwater trawl operated over purse seine and passage on portside. Much larger working space on deck, especially on starboard side. Sampling conditions much improved.

5. *Fishing gear*

a. Purse seine, 1972, modified 1975 for shallower waters
b. AKRA trawl, 1973?
c. Semi balloon, shrimp and fish trawl, July 1975
d. Semi balloon shrimp trawl
e. Midwater trawl Engel, 308 meshes circ. by 800 mm stretched mesh. February 1976
f. Skiff, 7 x 2 meters, fiberglass with 2 outboard motors, 40 hp. Johnson
g. Underwater lamps (4) - 1000 watt bulbs
Overwater lamps (2) - 500 watt bulbs
Generator for skiff, 2 KW, portable. Honda
h. Trolling lines with lures
i. Gillnets (hardly used and many not recovered).

available and used.

The most important instrument was a sonar (Simrad SK3), which was used constantly in sweeping mode. Furthermore, the vessel was equipped with two rather primitive echosounders, which were eventually replaced by an echosounder suitable for more refined detection of fish traces (Simrad EQ 50). Further details of the vessel, equipment and gear are presented in Box 1.

The first FAO biologist trained his Indonesian colleagues in the use of oceanographic equipment, sampling and, above all, data recording. During all surveys a well-designed logbook was kept, which did not only contain a record of all major biological events, but also observations on fishing activities along the cruise tracks. The latter were copied on tracing paper at the same scale as the original charts. All data, charts, echosounder paper and sonar paper were taken to the Marine Fisheries Research Institute in Jakarta for processing. Unfortunately, a proper system of data processing and reporting was lacking. After a few attempts, biological cruise reports failed to appear. Although the FAO masterfisher partly compensated for the lack of reports from the biologist by issuing a rather elaborate report of his own (Bjarnason 1977), the overall situation was very unsatisfactory and the data were piling up at an alarming rate. At the beginning of 1975, material collected during more than 300 sea days (30 cruises) had accumulated, while new data were being collected almost continuously.

In early 1975, the highest priority was thus to reduce the cruise tracks to a size where the charts would become manageable, so that observations could be plotted along the tracks. It took about 6 months before this work was completed and then another year of intensive work to plot the data on the charts and to gather all related observations. The (wet!) sonar paper was kept in sealed tins, but by the time it was processed, it had dried out and the echograms were barely visible. Had it not been for the very good logbook records, it would have been impossible to use this material.

Although the bulk of the available data were "saved" in the mimeographed report (Venema 1976), it appears that very few scientists, in Indonesia and elsewhere, have been aware of the existence of this report and hence little use has been made of the data.

Surveys with pelagic gear in tropical seas are notoriously difficult and the number of successful fishing operations with the purse seine and midwater trawl was rather limited. Hence, the amount of biological data on pelagic species was very much lower than the hundreds of samples collected on demersal species during the trawl surveys documented elsewhere in this volume.

An additional drawback for data collection before 1975 is that the number of fishing operations was kept to a minimum in order "not to take fish away from the artisanal fishers". This singular philosophical position of the first FAO biologist resulted in the amount of information available from the lightly fished pelagic resource of Bali sardinella being very limited. This resource is now overfished (see Pauly et al., this vol.) and data from the early period would be most useful for stock assessment purposes.

Nowadays it is unthinkable that surveys, sampling and data processing should be conducted this way. Indeed, many of the lessons learned from *R/V Lemuru* surveys have been incorporated in FAO manuals and guidelines for managers of fishery research vessels.

The more significant results of the surveys have been plotted on charts. This was done in a rather primitive way, by sticking a variety of symbols along a hand-drawn cruise track, with subsequent reduction by a photocopier.[b] Since the fisheries and the data collection based on these have developed very much since the 1976 data report was produced, it was not considered worthwhile to reproduce here all of the data sets in this paper, and only a selection of (redrawn) maps is presented. Interested researchers may get access to the original data via the Marine Fisheries Research Institute in Jakarta, FAO's Fisheries Library in Rome, or the ICLARM Library in Manila, which all hold copies of Venema (1976).

Most of the data in the data report, and hence in this paper, were collected by the biologists Dr. Gede Sedana Merta (1972-76), Dr. Subhat Nurhakim (1973-75) and Mr. Edi Amin (1974-76) and by the assistant biologists, Mr. Isom Hadisubroto (1973-74), Mr. Dadang Karyana (1975) and Mr. Sudjianto (1975-76). Dr. Subhat, assisted by Messrs. Karyana and Sudjianto managed to reconstruct all cruise charts. For all involved in the work with *R/V Lemuru*, the cruises were an unforgettable experience, which generated profound knowledge of major Indonesian sea areas and their resources. It is hoped that this paper will lead to a recognition of the work done by the above Indonesian scientists, during 3.5 years on 48 cruises with a total of 588 seadays and an additional estimated three person-years for data processing.

Environmental Aspects and Migrations of Pelagic Resources

Most fisheries in Indonesia and, in particular, the pelagic fisheries in the Bali Strait, Java Sea and adjacent areas of the South China Sea are seasonal (Bailey et al. 1987). The migration patterns of the most important pelagic resource of the Java Sea (*Decapterus* spp.) and their relation with the monsoons were described by Hardenberg (1937, 1938) and by Potier and Boëly (1990) (Fig. 2 and Box 2).

The influence of oceanic waters is much stronger in the eastern part of the Java Sea, and this results in higher abundances of pelagic fish, in particular layang scads (*Decapterus* spp.). Soemarto (1958), also based on Hardenberg (1937), described their migratory behavior and distinguished three groups of layang, viz.,

1. *East layang* enters the Java Sea with the oceanic water from the Flores Sea during the dry northeast monsoon (May to September). This group may spawn near Bawean Island in June;

[b]The original charts have been lost; Figs. 3-11 were redrawn from photocopies.

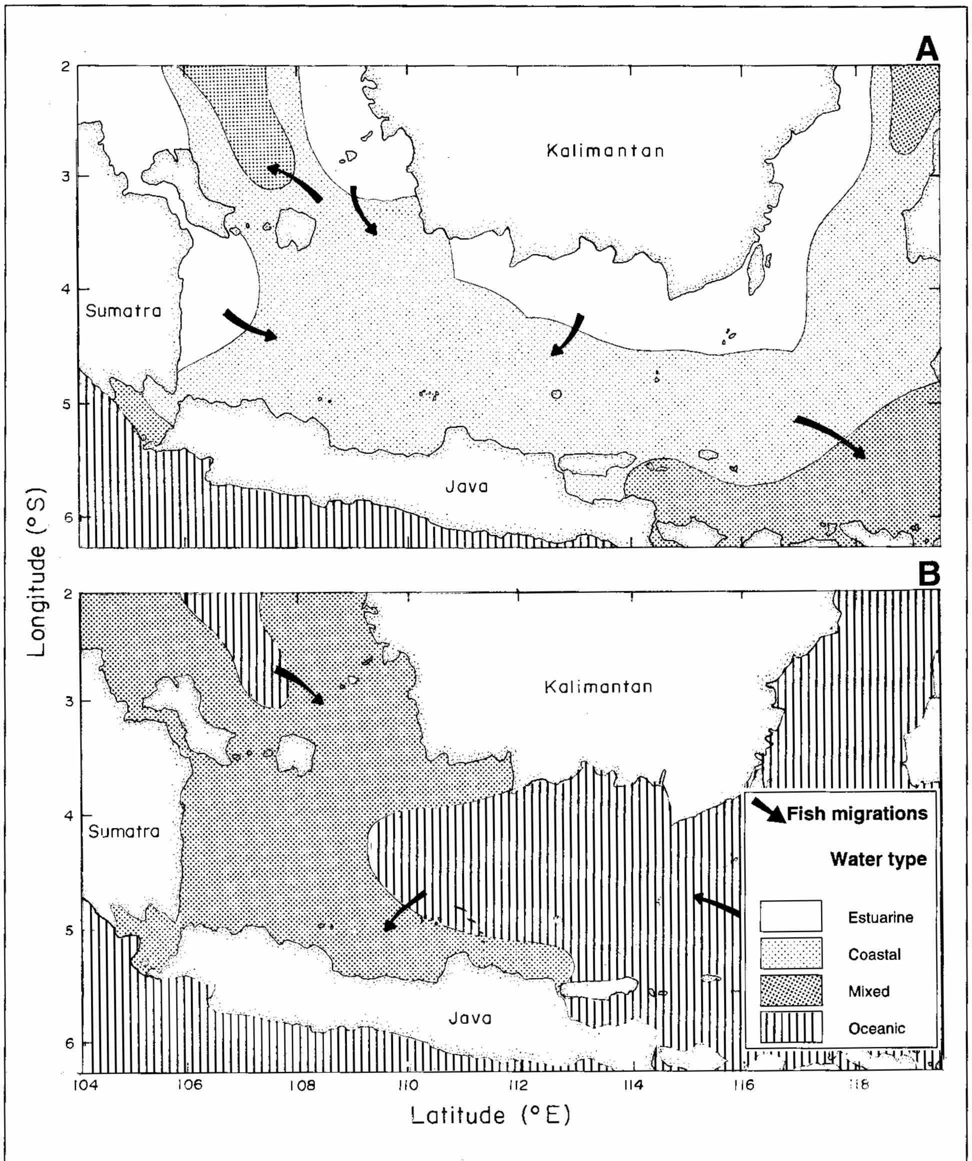

Fig. 2. Water masses and pelagic fish migrations in the Java Sea, by season: A) wet monsoon (November to March); B) dry monsoon (May to September). (Modified from Potier and Boëly 1990, and Hardenberg 1937, 1938).

[Gambar 2. Massa air dan migrasi ikan pelagis di Laut Jawa, berdasarkan musim: A) musim hujan (November hingga Maret); B) musim kemarau (Mei sampai September). (Modifikasi dari Potier dan Boëly 1990, dan Hardenberg 1937, 1938).]

Box 2. Seasonality of pelagic fish abundance in the Java Sea.

[Boks 2. Kelimpahan ikan pelagis di Laut Jawa sesuai dengan musim.]

A. *Dry monsoon* (winds from N.E.) - May to September:

Currents in the Java Sea from East to West, strong influx of oceanic waters with high salinity, in particular in the eastern part of the Java Sea (Area 1).
At first (May) very low abundance of pelagic fish but then rapidly increasing.

B. *Intermonsoon* - October

Weak current, strong mixing.

Highest abundance of pelagic fish.

C. *Wet monsoon* (winds from N.W.) - November to March

Currents in the Java Sea from West to East, heavy rains, strong outflow from rivers, in particular from Kalimantan and lower salinities. Pelagic fish move to the other seas and the central part of the Java Sea. A sharp decline in catch rates starts in December and continues to reach a deep low in March.

D. *Intermonsoon* - April

Currents weaken, waters get mixed. A small peak in abundance can be inferred from catch rates.

2. *West layang* enters the Java Sea with oceanic waters from the Indian Ocean through Sunda Strait during the northwest monsoon (November to March);
3. *North layang* enters the Java Sea with oceanic waters from the South China Sea through the Straits of Gaspar and Karimata, also during the northwest monsoon (November to March).

[The West and North layang tend to avoid a triangular area whose base is formed by the southeastern coast of Sumatra and the island of Bangka; see below].

Based on this, one should expect (1) generally higher abundance of pelagic fish in the eastern Java Sea from May to September, and low abundances towards the end of the wet monsoon in March, and (2) a higher abundance of pelagic fish in the Sunda Strait, along the adjacent North Java Coast and off southwestern Kalimantan from November to March (see also Box 2). However, a complete model of the life cycles of the various *Decapterus* species has still to be developed. It is quite likely, for example, that *Decapterus* spp. do not spawn in the Java Sea, but outside in deep waters, where no fishery takes place. There is no information on the distribution of eggs and larvae, while spent fish has only been encountered a few times in the Java Sea.

It is possible and even likely, that the Java Sea is mainly a nursery area for *Decapterus* spp. A full understanding of the life cycle is, of course, essential for a complete assessment of the stocks of these commercially important species.

The survey results inAreas 1, 2 and 5 as described below may be seen as a contribution to the resolution of this and related issues.

Relationships between envirqnmental conditions and the abundance of Bali sardinella have also been noted (Soerjodinoto 1960; Dwiponggo 1974). For spawning, *S. lemuru* comes inshore, especially in the northern part of the Strait where salinities are low, in particular during the rainy season. The growing fish move towards the shelf of Bali closer to the Indian Ocean and out of reach of sailing boats operating from Muncar and other harbors in the northern area. So, in the past, the fishery concentrated on juveniles in the northern area, while mature fish were rarely caught. This was still the case during the *R/V Lemuru* surveys from 1972 to 1974.

The very high concentration of densely packed schools of *S. lemuru* is a phenomenon that rarely occurs elsewhere in tropical waters and it is therefore logical to assume that it is associated with upwelling, as in the case of the Indian "oil sardine" (*S. longiceps*). Previously it was assumed that the abundance of *S. lemuru* was associated with the (weak) upwelling in the open Indian Ocean waters off Java and Sumbawa, identified by Wyrtki (1962). Nowadays it is considered more likely that the occurrence of dense schools of *S. lemuru* is due to the strong upwelling *within* the Bali Strait. This would also explain why concentrations of *S. lemuru* are rarely found in the adjacent Indian Ocean. Ghofar and Mathews (in Pauly et al., this vol.) discuss the fluctuations on *S. lemuru*

Table 2. Catch by trolling of *R/V Lemuru* by species (A) and time of the day (B), 1972-1976, by areas.
[Tabel 2. Hasil tangkapan tonda menurut daerah oleh kapal penelitian Lemuru *berdasarkan spesies (A) dan waktu penangkapan (B), 1972-1976 dan menurut daerah.]*

A. Numbers caught, by area

Species	Area 1	2	3	4	5	6	7	8	All (%)
Atule mate	-	-	-	-	-	-	1	-	0.3
Caranx sp.	-	-	-	-	-	-	2	-	0.6
Elagatis bipinnulatus	1	-	-	-	1	7	3	5	4.7
Megalaspsis cordyla	-	-	-	-	-	-	4	4	2.2
Scomberoides commersonianus	-	-	-	2	-	-	-	-	0.6
Chirocentrus dorab	-	1	-	-	-	-	-	-	0.3
Coryphaena hippurus	2	-	1	-	6	2	1	3	4.2
Acanthocybium solandri	-	-	-	-	1	-	3	2	1.7
Auxis thazard	-	-	-	-	-	1	1	3	1.4
Euthynnus affinis	25	9	2	-	-	14	44	19	31.3
Katsuwonus pelamis	1	-	-	2	11	9	2	26	14.1
Sarda orientalis	-	-	-	-	-	-	8	3	3.0
Scomberomorus commerson	4	11	2	-	4	2	7	6	10.0
Scomberomorus guttatus	1	-	-	-	-	-	-	-	0.3
Thunnus alalunga[a)]	5	-	-	-	-	4	-	-	2.5
Thunnus albacares	10	-	-	-	-	6	6	15	10.2
Thunnus tonggol	8	6	22	-	-	-	-	-	10.0
Trichiurus lepturus	1	-	-	-	-	-	-	-	0.3
Sphyraenidae	3	-	-	-	1	3	-	2	2.5
Total	61	27	27	4	24	48	82	88	100

B. Percentage of total catch, by hour of the day.

Hour	1	2	3	4	5	6	7	8	All
5 + 6	8	7	3	0	4	2	6	5	5
7 + 8	18	48	3	25	29	2	16	14	16
9 + 10	41	3	7	50	33	10	23	13	20
11 + 12	8	11	56	0	21	6	21	10	16
13 + 14	13	3	22	0	13	27	10	23	16
15 + 16	10	15	3	0	0	33	18	26	18
17 + 18	2	11	3	25	0	19	6	10	8

[a]These may have been misidentified young bigeye tuna (*Thunnus obesus*), as young *T. alalunga* cannot tolerate temperatures > 26°C (Gary Sharp, pers. comm.).

Table 3. *R/V Lemuru* purse seine catches by areas, 1972-1976.
[Tabel 3. Hasil tangkapan purse seine kapal Lemuru *berdasarkan daerah, 1972-1976.]*

Area	Number of sets		Total catch (kg)					
	Total	Valid	0	1-49	50-199	200-999	1,000-2,999	≤3,000
1	53	49	9	13	5	10	4	8
2	21	18	1	12	1	3		1
3	3	2		1	1			
4	-	-						
5	6	6	1	2		1	1	1
6	4	3	1	1	1			
7	18	17	3	5	2	2	2	3
8	1	1	-	-	-	-	1	-
All	106	96	15	34	10	16	8	13

Table 4. Frequency of occurrence of pelagic species in *R/V Lemuru* purse seine catches over 100 kg.
[Tabel 4. Frekuensi keberadaan ikan pelagis pada hasil tangkapan kapal Lemuru *yang beratnya lebih dari 100 kg.]*

	Area 1	2	5	6	7	8	Total
Number of sets	28	5	3	1	9	1	47
Sharks	7	-	-	-	-	-	7
Ariidae	6	-	-	-	1	-	7
Alepes spp.	3	-	-	-	-	1	4
Caranx spp.	2	1	3	-	-	1	7
Decapterus spp.	13	-	-	-	1	1	15
Elagatis bipinnulatus	-	-	1	-	-	-	1
Megalaspis cordyla	4	-	1	-	1	-	6
Selar spp.	7	-	-	-	3	-	10
Seriolina nigrofasciata	1	-	-	-	-	-	1
Scomberoides commersonianus	2	-	-	-	-	-	2
Chirocentrus dorab	2	-	-	-	-	-	2
Dussumieria acuta	2	-	-	-	-	-	2
Sardinella lemuru	5	-	-	-	6	-	11
Sardinella brachysoma	1	-	-	-	-	-	1
Sardinella gibbosa	5	3	-	-	-	-	8
Amblygaster sirm	12	1	-	-	1	-	14
Stolephorus spp.	3	-	-	-	-	-	3
Caesio cuning	4	-	-	-	-	-	4
Lutjanidae	2	-	-	-	-	-	2
Auxis thazard	-	-	1	-	2	-	3
Euthynnus affinis	5	1	1	-	1	-	8
Rastrelliger brachysoma	2	-	-	-	-	-	2
Rastrelliger kanagurta	16	-	1	-	1	-	18
Scomberomorus guttatus	14	-	-	-	-	-	14
Sphyraenidae	5	-	-	-	1	-	6
Diodontidae	1	-	-	-	-	-	1

Table 5. *R/V Lemuru* bottom trawl catch rates, by areas, 1972-1976.
[Tabel 5. Laju tangkapan jaring trawl kapal Lemuru *berdasarkan daerah, 1972-1976.]*

Area	Number of hauls Total	Valid	Duration (hours)	Total catch (kg)	Density (kg·hour^{-1})
1	45	39	44	5,593	127
2	37	36	37	1,743	48
3	1	1	1	27	(27)
4	12	12	17	493	41
5	9	9	10.5	1,014	97
6	57	56	81	18,252	225
7	27	21	22	4,624	210
8	30	28	27.5	4,244	154
All	217	201	240	35,990	150

catches from 1950 to 1993.

In the following sections, the *R/V Lemuru* survey results are described by (sub)area, except for the single coverage of the Malacca Strait (partly documented in Martosubroto et al., this vol.) and of the South China Sea (for which Venema 1976 must be consulted).

Prior to this, however, a few tables are presented with summary data for Areas 1-8, for trolling (Table 2), purse seining (Tables 3 and 4) and bottom trawling (Tables 5 and 6). Only few explicit references will be made to these tables, which, however, should be consulted when reading the area-specific accounts below.

Eastern Java Sea, Area 1

Sixteen cruises were made in Area 1; this area is large and therefore the results are discussed by subareas: (a) Madura Strait, (b) North coast of Java and Madura (c) South coast of Kalimantan, and (d) Makassar Strait and the eastern edge of Sunda Shelf. This is followed by general remarks pertaining to the whole of Area 1.

a. The *Madura Strait* is a rather small enclosed area, very shallow on the western side with a channel leading towards Surabaya, and very deep on the eastern side. The shallow part may be a spawning area for Indian mackerel (*Rastrelliger* sp.) while the deep waters are a fishing area for tuna (trolling). A large number of fishers lived on the East Java coast (e.g., Probolinggo, Kembung Island and South Madura). There were always a large number of artisanal crafts (*praus*), especially on the eastern side, where liftnets (*bagans*) were also plentiful. Small handliners were active on the east side of Madura (Raas Strait). The Madura Strait was surveyed only in April-July, thus seasonal patterns could not be determined. Quite a few schools were detected, especially on the shallow side, during cruises 7304 (May-June), 7405 (April-May), 7507 (July, sonar count 130 t) and 7604 (April, sonar count 205 t). The schools were usually small to medium size and not always easy to catch.

b. *North coast of Java and Madura*: Madura is a flat island, with no large harbors on the north coast, which in fact consists of one long beach. The north coast of East and Central Java is mainly low marshland where salt is panned. There are many fishing harbors with, at that time, mainly sailing praus fishing payang nets and handlines. Just east of Semarang behind a mountain lies Jepara, a populous fishing harbor, with many fixed liftnets. Near Semarang there were always a large number of active small praus as well as a fleet of approximately 50 "chungking" type shrimp trawlers.

The coastal waters are shallow and trawlable in most parts. The islands of Bawean, Masalembo, Arends and the Karimun Java archipelago were also centers of fishing activities, especially Bawean. Concentrations of boats were also found off North Madura, and halfway between Semarang and Surabaya (112°E). There were a large number of bagans near Gresik (Surabaya), off North Madura and near Semarang.

The area immediately north of Madura was quite rich in demersal fish (Fig. 3A). Many pelagic schools were also found there in July 1975 (Fig. 3B). The area near Surabaya was rich as well, as was the stretch just north of Semarang. Good concentrations of fish were found frequently near all the island groups (Karimun Java, Bawean, Masalembo). Fish densities

Table 6. Frequency of occurrence (in %) of various taxa in bottom trawl catches of *R/V Lemuru*[a].
[Tabel 6. Frekuensi (dalam %) tertangkapnya berbagai taksa ikan oleh jaring trawl dasar pada kapal Lemuru[a]*.]*

	Area							
	1	2	4[b]	5	6	7	8	All
Valid hauls	40	37	12	9	55	23	25	202
Ariidae	70	24	67	33	55	43	16	46
Decapterus spp.	5	5	0	0	2	4	0	6
Megalaspis cordyla	15	3	0	44	2	4	0	6
Selar spp.	18	54	0	22	29	0	32	26
Anadontostoma chacunda	33	16	0	0	4	0	4	11
Dussumieria acuta	40	16	0	33	0	0	0	12
Sardinella lemuru	3	0	0	0	2	13	0	2
Sardinella gibbosa	8	5	0	0	0	0	0	2
Engraulidae	20	16	25	33	16	26	40	22
Formionidae	8	19	8	55	13	17	40	40
Gerreidae	60	57	83	55	9	4	4	11
Harpadontidae	0	3	8	0	9	0	0	3
Leiognathidae	90	68	83	55	13	17	40	40
Lutjanidae	30	5	58	22	65	0	0	29
Mullidae	90	95	92	88	35	65	60	69
Nemipteridae	43	65	92	88	20	35	52	46
Polynemidae	15	8	8	22	65	0	0	29
Pomadasyidae	53	35	83	22	18	30	32	36
Priacanthidae	45	49	50	66	45	35	24	43
Sciaenidae	60	38	33	44	20	61	44	41
Rastrelliger brachysoma	10	8	0	33	0	0	8	6
Rastrelliger kanagurta	23	11	0	33	0	0	12	9
Scomberomorus spp.	38	19	17	33	15	0	8	18
Sphyraenidae	48	24	17	44	24	17	44	31
Stromateidae	25	5	17	44	0	10	0	9
Synodontidae	85	76	92	88	60	61	64	72
Terapontidae	40	49	50	44	49	61	64	72
Trichiuridae	68	41	50	22	56	30	32	48
Apogonidae	38	16	50	33	9	35	28	25
Diodontidae	8	8	0	0	2	0	0	3
Fistularia spp.	43	38	50	55	5	82	4	24
Platycephalidae	20	35	58	33	9	26	0	21
Tetrodontidae	33	24	0	44	0	0	0	13
Penaeid shrimps	78	76	66	44	71	48	60	73
Squids	70	81	92	77	49	26	40	45
Cuttlefish	50	65	83	33	0	0	24	32

[a]Excluding Area 3 (with only one haul).
[b]Details on these 12 hauls may be found in Martosubroto (this vol.) and in Torres et al. (this voi.)

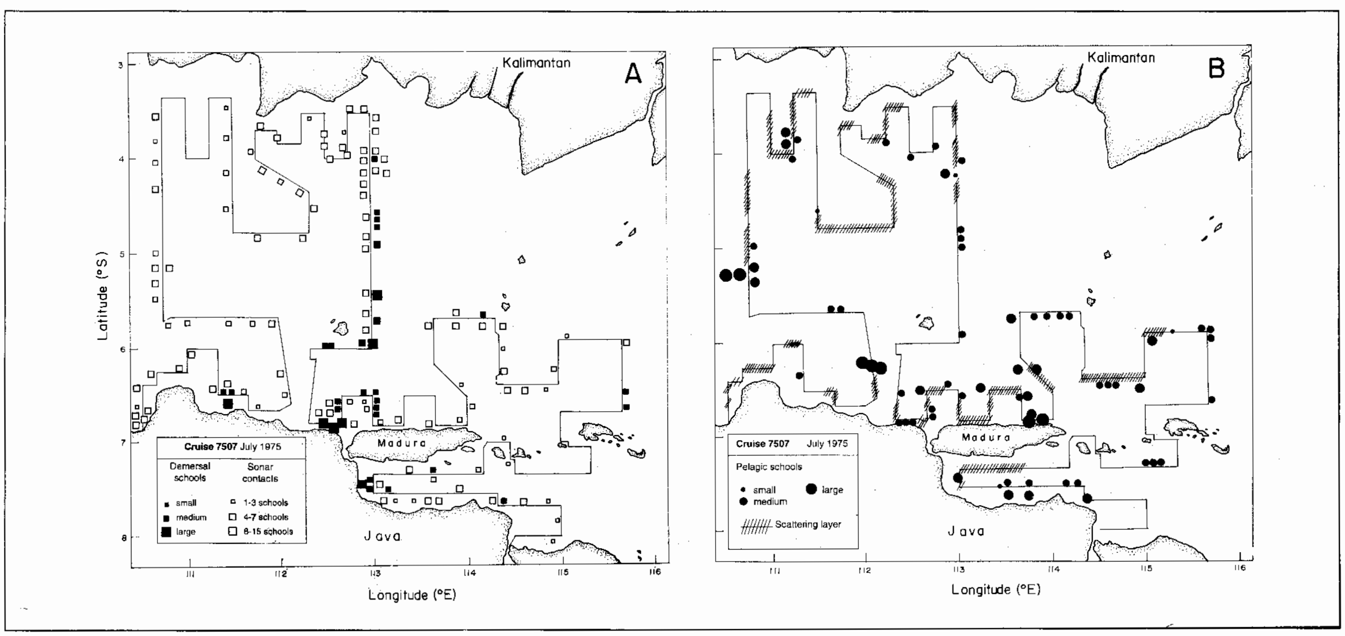

Fig. 3. *R/V Lemuru* survey tracks off northeastern Java and Madura, Area 1 (Cruise 7507): A: demersal schools; B: pelagic schools.
[Gambar 3. Pelayaran survei kapal penelitian Lemuru *di sekitar timur laut pulau Jawa dan Madura, Daerah 1 (Pelayaran 7507): A: gerombolan ikan demersal; B: gerombolan ikan pelagis.]*

in the central part of the Java Sea were generally low, except during cruise 7507 (July), when high densities were found almost everywhere (Fig. 3). The same area was virtually devoid of fish during March 1976 (7603).

c. *The south coast of Kalimantan* consists of low lying marshland covered by a dense jungle. There are many shallow bays in which several huge rivers reach the sea (notably the Sampit River, and the Barito River). Near the mouth of the Sampit River the Department of Fisheries had cold storage facilities and an ice plant; however, the only fishing settlements were found at the banks of estuaries, and fishing activities were very low. Fishers from Java were reported to operate there, but not many were observed from *R/V Lemuru*. A group of three small islands, the Laurot Islands or Pulau Laut Kecil (4-5°N and 115-116°E) seemed to be the best fishing area in the Java Sea, but only a few local fishers were active there.

The south coast of Kalimantan proper was sparsely covered by the survey. A first complete coverage was done during cruises 7505 (May) and 7506 (Fig. 4A) while the whole area was surveyed once more in January 1976 (Fig. 4B).

The coastal area near Banjarmasin, near the mouth of the Barito River, had large fish concentrations in June/July 1975 (7506) (Fig. 4A). The echosounder did

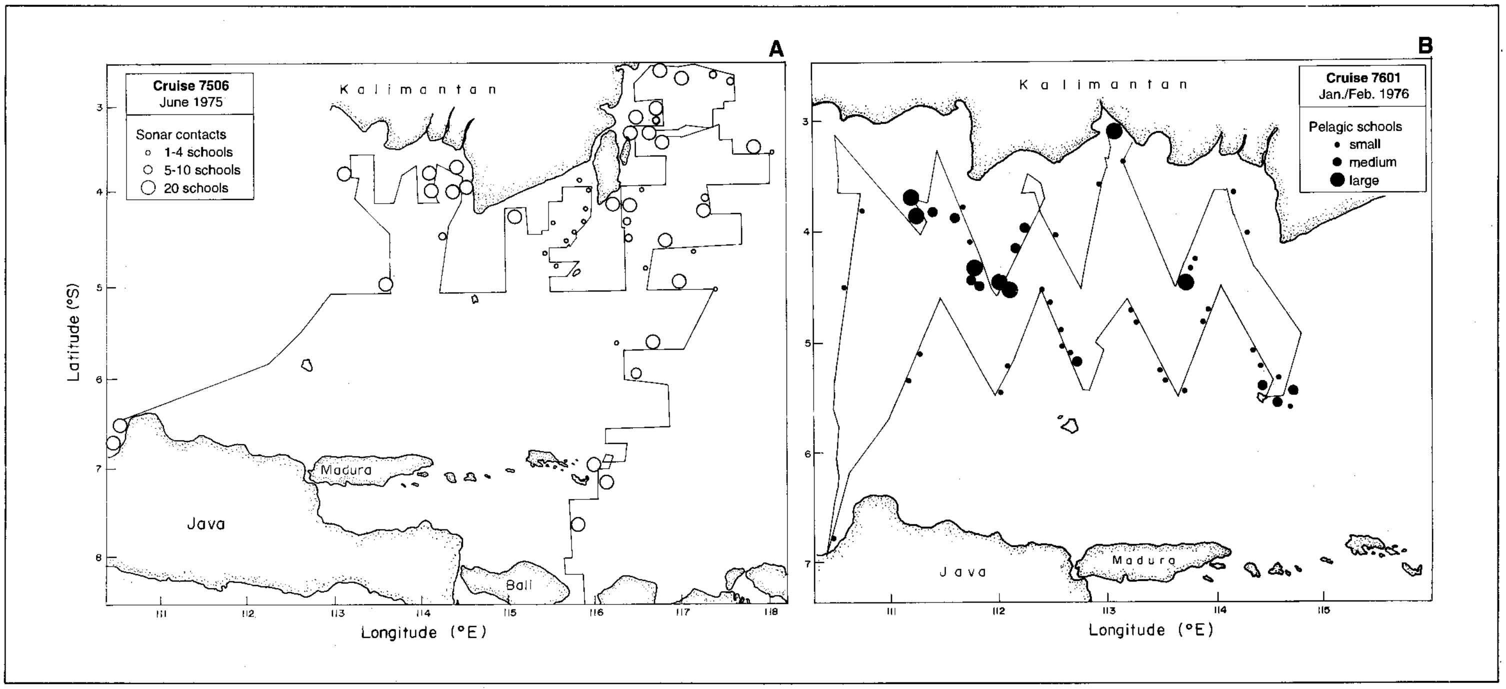

Fig. 4. *R/V Lemuru* survey tracks off southeastern Kalimantan, Area 1: A. Cruise 7506: density of sonar contacts; B. Cruise 7601: density of pelagic schools. *[Gambar 4. Pelayaran survei kapal penelitian* Lemuru *di sekitar tenggara pulau Kalimantan, Daerah 1: A. Pelayaran 7506: kepadatan sonar kontak; B. Pelayaran 7601: kepadatan gerombolan ikan pelagis.]*

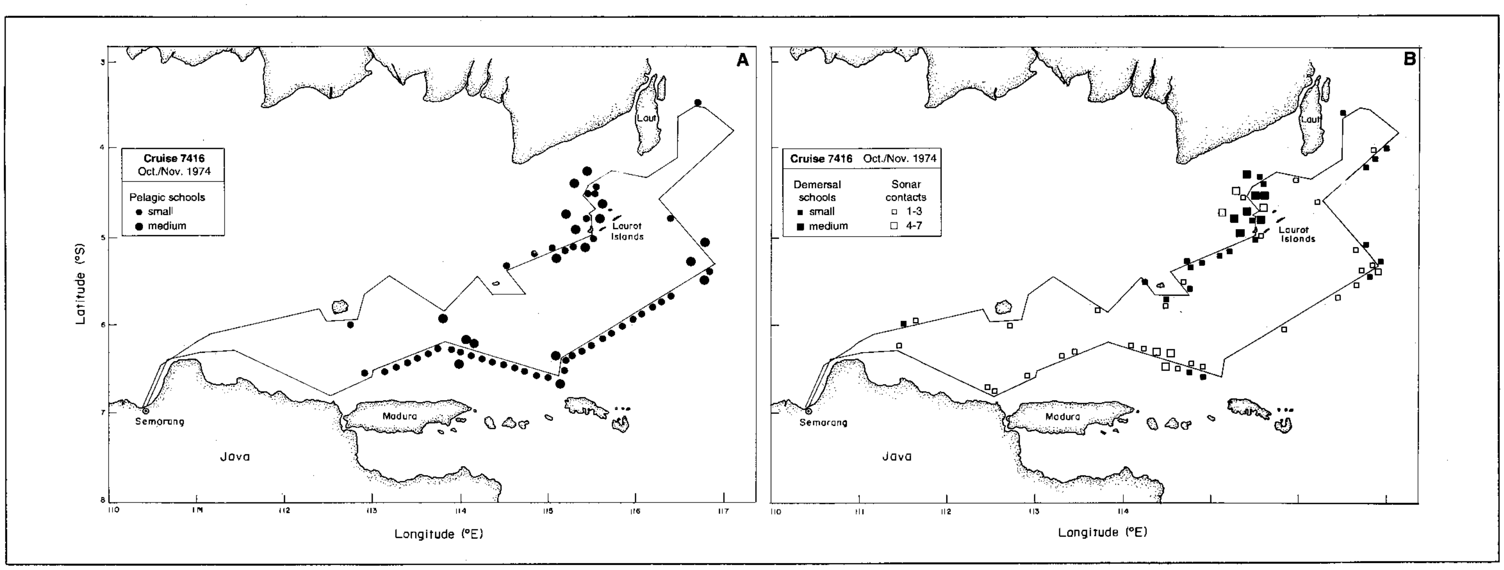

Fig. 5. *R/V Lemuru* survey tracks around the Laurot Islands, Area 1 (Cruise 7416): A. pelagic schools; B. demersal schools. *[Gambar 5. Pelayaran survei kapal penelitian* Lemuru *di sekitar kepulauan Laurot, Daerah 1 (Pelayaran 7416): A. gerombolan ikan pelagis; B. gerombolan ikan demersal.]*

not "confirm" all sonar contacts, but several successful purse seine sets did. A very good catch of shrimp (200 kg·hour^{-1}) was also made south of Banjarmasin.

A concentrated survey was made in Sampit Bay; a large number of small schools were located at the edge of a small trench, the fish consisting of engraulids, clupeids and carangids. The Laurot Islands area (Fig. 5) was surveyed for the first time in October 1974, when many schools were detected. More schools were found during the next cruises in October and November 1974 (Fig. 5). In May 1975 (7505), only a short period of time was spent there, and only medium-size schools were observed, while during Cruise 7506 (June) the area was virtually devoid of fish. In October 1975 (7510), fish was found east and west of the islands, while in March 1976 (7603) several medium-size schools were encountered.

d. *Makassar Strait and the eastern edge of Sunda Shelf.* The Java Sea ends abruptly where the Sunda Shelf drops off towards the Flores Sea and Makassar Strait. The edge is very rocky with many coral patches and small islands, the largest of which are the Kangean group. The Laut Island is separated from Kalimantan by a narrow, muddy channel, but east of 117°E there are again plenty of rocks and corals, with a steep drop off towards the central Makassar Strait.

The coast of South Sulawesi borders deep waters in the north (Mandar coast) and a shallow shelf area full of small islands and corals south of Barru. Some more coral reefs and islands lie in the middle of the Strait.

This area was surveyed as part of 5 cruises (7416, 7505, 7506, 7510 and 7603). During all cruises results were poor to very poor. Some small to medium-size schools were detected at the edge of the shelf in cruise 7416 (November) (Fig. 5B). Quite a few pelagic schools were detected during cruise 7505 (May), but these consisted mainly of pufferfish and flyingfish. A few bottom schools were detected above bottom outcrops. In June (7506), quite a few sonar contacts were made north of Laut Island and along the edge of the shelf (Fig. 4A), but echosounder recordings were less positive on the latter part.

The number of demersal schools was particularly low. Very few schools were detected on the echosounder in October 1975 (7510), but quite a few sonar contacts were made. In March 1976 (7603), several medium-size bottom schools were recorded on the new echosounder and the area north of Laut was found to be quite rich. Sonar contacts coincided with those recordings.

A few boats were present near small islands and larger numbers near Laut Island (Kotabaru) where there were also many bagans, and at the Mandar coast, especially near Pare Pare and outside Ujung Pandang.

Sightings of flying fish were very frequent in Makassar Strait, as might be expected given the existence of a fishery on *Cypselurus* spp. in the area. Also observed were tuna schools, porpoises and surface schools; they occurred as well near the edge of the Sunda Shelf and between Bali and Madura.

Light attraction was tried several times just north of Bali, without success. During the four commercial type cruises, light attraction near the Laurot Island was reasonably successful and was followed several times by purse seine sets. In 1975 and 1976, light attraction was less successful, possibly because only a short time was spent in areas with known concentrations.

Out of a total of 52 purse seine sets, the average of the 30 successful sets (> 100 kg) was 2.4 t, with a maximum of nearly 19 t (cruise 7510), consisting mainly of catfish (*Arius* spp.). Some good catches were recorded in Madura Strait (7305, June, and 7604, April). However, fish were not easy to catch in this shallow area.

Bottom trawl hauls were made frequently, especially in the Makassar Strait area. The bottom was found suitable for trawling in most areas except near the drop off in Makassar Strait and Flores Sea. The highest yield was obtained in June, cruise 7506 (669 kg·hour^{-1}, of which 74% were leiognathids), while in one haul over 200 kg of shrimp were caught. The average catch rate of all 39 valid hauls made in Area 1 was only 127 kg·hour^{-1}.

Trolling catches were made during all cruises, and consisted of many different species, with yellowfin tuna and longtai tuna dominating (Table 2).

Midwater trawl was used three times near the Lauro Islands, once yielding a high catch of sharks and black pomfret and five times in Makassar Strait, where three attempts were made to sample the deep scattering layer. This yielded myctophids, small red shrimps and small squids (see also Lohmeyer, this vol.). The same deep sea species were obtained from a similar set in Madura Strait (Cruise 7604).

Overall, the fishing operations in Area 1 did not always match the areas of highest abundance of fish. It appears tha there were potentially large fishing grounds south of Kalimantan and near the Laurot Islands which were, in the mid-1970s practically untouched. Seasonal fluctuations in fish abundance were apparent, although not as obvious as in Area 2 (see below).

High concentrations of fish were found in several parts of Area 1 from April to November, while the South Kalimanta coast was also quite rich in fish in January 1976, unde exceptionally bad weather conditions. The Makassar Stra seemed to be poor in pelagic fish. High concentrations of demersal fish were found in areas where bottom trawling wa impossible or difficult (two nets lost). Development of demersal fishery at the edge of the Sunda Shelf might b feasible, but not based on bottom trawling.

In 1976, development of a fishery around the Laur Islands to operate with purse seines or similar gear appeare recommendable; it was also recommended to survey th shallow waters not covered by *R/V Lemuru*, especially alor the South Kalimantan coast.

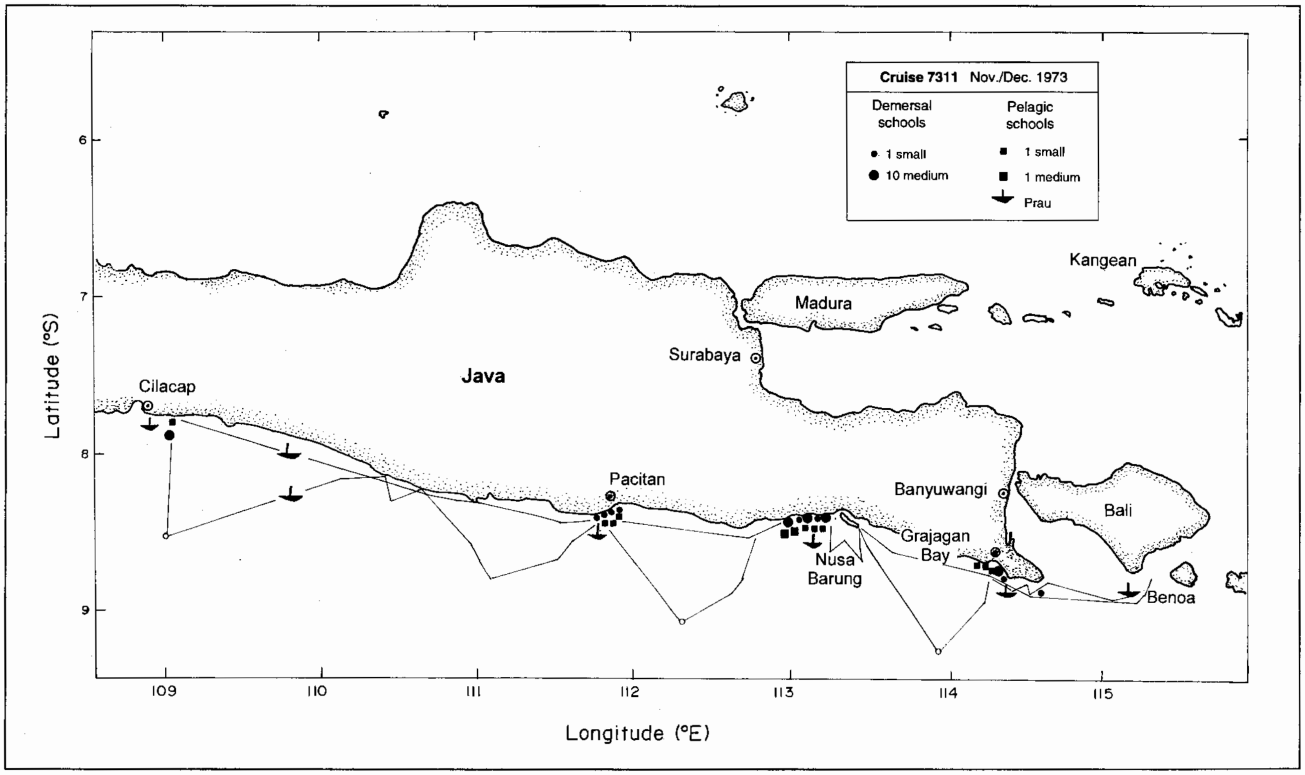

Fig. 10. *R/V Lemuru* survey track off southeastern Java, Area 6 (Cruise 7311, 22 November - 3 December 1973).
[Gambar 10. Pelayaran survei kapal penelitian Lemuru *di sebelah tenggara pulau Jawa, daerah 6 (Pelayaran 7311, 22 November - 3 Desember 1973).]*

smaller fishing villages, of which Pelabuhan Ratu, being relatively close to Jakarta, is the most important, are situated at small bays and near river mouths.

Most fishing activities occurred at a few places: Pelabuhan Ratu, Cilacap, Pacitan (see Figs. 9 and 10), Nusa Barung and Grajagan Bay. A fleet of approximately 80 trawlers fished for shrimp off Cilacap and a few smaller fishing grounds further east.

Schools of porpoises were sighted frequently, as well as jumping tuna, flying fish, etc. A few whale sharks (*Rhincodon typus*) were seen as well. However, the quantities of fish observed with sonar and on the echosounders were not large. In December 1972, July 1973, January 1974, February 1974, and June 1974, when the whole area was "run through", very little fish was recorded. Quite a few schools were observed in August 1973 (7307) along the entire coast between Cilacap and Benoa. In November of that year, a lot of fish was detected in small bays, but none in the deeper waters and in the areas lying between. The charts of Cruises 7411 and 7311 (Fig. 10) show where the fish were concentrated.

Thirty-four light fishing stations were made in this area but only a few were successful. Species attracted included squid, halfbeaks, sardines, Indian mackerel and scad. Most successful were the stations where an anchorage was sought inshore.

Only four purse seine sets were made, of which the first one was sheer disaster, as it took ten hours to haul the net on board. Only one set was successful with a catch of 114 kg of frigate tuna (*Auxis* sp.).

Bottom trawl catches were surprisingly good in this area, the average catch rate of 225 $kg \cdot hour^{-1}$ (n = 57) being the highest achieved among all areas (Table 5). Indeed, a single haul of more than 1.5 $t \cdot hour^{-1}$ was achieved (on Cruise 7311), which, considering the small net as *R/V Lemuru's,* must be considered very good.

The trawlfish species composition did not differ much from that of other areas, although the high occurrence of snappers was noteworthy. Small croakers (Sciaenidae) were also abundant. Leiognathids were also a dominant species here, both in terms of volume and rate of occurrence (Table 5).

Trolling catches were lower than might be expected, especially in 1973. Yellowfin tuna, little tuna and skipjack were caught, as well as blue runners, dolphinfish, Spanish mackerel and barracudas.

The conclusion (drawn in 1976) for this area was that pelagic resources availability was low overall. The results of the bottom trawl hauls were better, although the total stocks may be small. It would seem worthwhile to exploit this resource because it is so close to markets where it is most needed.

Nusa Tenggara, Area 8

The Nusa Tenggara area consists of a chain of islands east of Bali, between the Indian Ocean and the Flores Sea (see also the report of surveys by *Bawal Putih 2* by Martosubroto, this vol.) and includes the sea area between Sumba, Flores and Timor (the "Sawu Sea"). There are a large number of straits between the islands, e.g., the Lombok and Alas Straits, which connect the Pacific with the Indian Ocean. Due to differences in water level between the two oceans, there is always a strong current towards the Indian Ocean, which hinders navigation, even of vessels like *R/V Lemuru*, and precludes the use of certain fishing gears, such as the purse seine.

The area was visited in four cruises (7303, 7309, 7404 and 7409), which reached as far east as 125°E. Most of the tracks were made over the narrow continental shelves of the various islands, nearly always on the Indian Ocean side, except in cruise 7404 when the north coast of Sumbawa (Flores Sea) was covered as well.

The presence of an FAO-TF Fisheries Project in Lomblen Island stimulated visits to this area in particular, also because *R/V Lemuru* was carrying supplies for the Project. The authorities in Kupang always showed great interest in the vessel's activities in this area, and demonstration fishing was thus carried out a few times.

Local fishing activities were restricted to a few places, as this area is arid and not densely populated. Some coastal concentrations of praus were found in the Alas Strait, around the eastern part of Flores, between Lombok and Sumbawa, and near Lomblen Island.

Sightings of surface schools of flyingfish and tunas were numerous. Also, a large number of whales were seen between Flores and Timor during Cruise 7309 (October-November), while a few whales were also seen off Lombok and Sumbawa in July 1974 (Cruise 7409).

The number of schools picked up by the sonar could be determined from the logbooks only for the 1974 cruises. In March/April, only a few contacts were made, always inshore. In June-July more schools were picked up, also when crossing deep waters.

The echosounder recorded good schools in Alas Strait and south of Lombok during cruise 7303, but in November only one school was found, and none in March 1974. In a small bay off east Sumbawa, near Kupang (Timor) and in the Lomblen area, several, mostly small schools, were picked up.

A total of 52 light attraction stations was made, 46 times with *R/V Lemuru* anchored in shallow coastal waters and six times while drifting over deep to very deep waters. Squid and sardine-like fish were quite frequently observed near the lamps. Catches were made of those species, as well as of tunas, hardtail scad (*Megalaspis cordyla*) and layang scad (*Decapterus* sp.).

Some very large snappers were caught on handlines, e.g., one *Lutjanus argentimaculatus* of 11.7 kg near Komodo Island. The light attraction stations of Cruise 7409 had very little success, probably due to the full moon, combined with a nearly cloudless sky.

Only one purse seine set was made after light attraction, which yielded a mixture of jacks and squids, of which a large part escaped. The purse seine would have been shot more often if suitable schools and conditions had been encountered.

Twenty-eight valid and two invalid bottom trawl hauls were made in the area, with an average catch of 154 kg·hour^{-1}. One haul in Cempi Bay (8°44', 118°48') yielded 706 kg of mixed small fish (especially Leiognathidae, which were also the dominant family in other good catches). Large to medium-size fish were not encountered, and squid (max 0.2 kg·hour^{-1}) and shrimp (max. 3 kg·hour^{-1}) only in low quantities. Quite a few

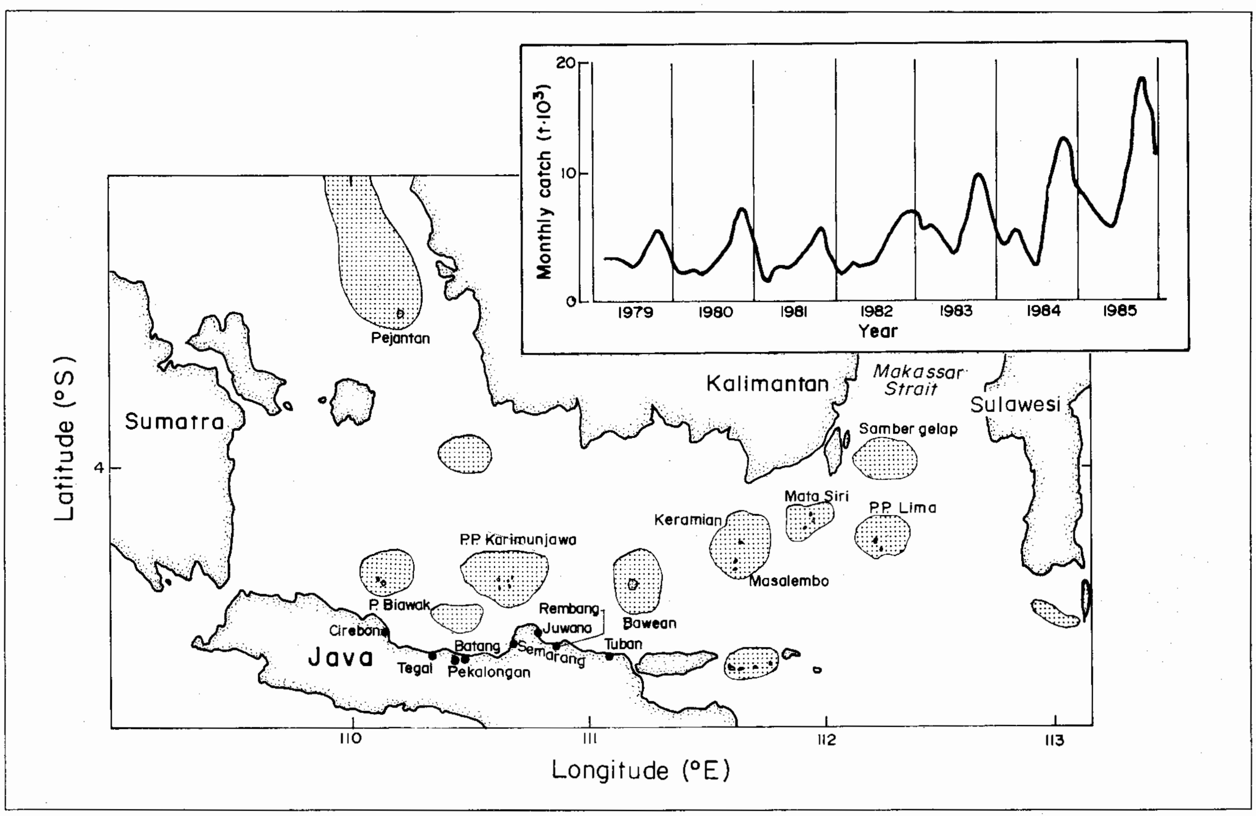

Fig. 11. Major fishing grounds of the Java Sea purse seine fishing (redrawn from Boëly et al. 1987); the inset shows a time series of catches from that fishery (smoothed over three months; from Potier et al. 1989).
[Gambar 11. Daerah penangkapan utama purse seine (pukat cincin) di Laut Jawa (digambar kembali dari Boëly et al. 1987); sisipan menunjukkan gambar hasil tangkapan tahunan (data gabungan kuartalan; diambil dari Potier et al. 1989).]

ments of purse seining techniques that simultaneously developed in Bali Strait saved this plan and brought it to fruition.

The development of the pelagic fisheries in the Java Sea is now closely monitored by a project funded by the European Union, and operated by ORSTOM (e.g., Boëly et al. 1987; Potier et al. 1989; see Box 4). The locations of the main fishing grounds of the purse seiners in the Java Sea, with layang scads (*Decapterus* spp.) as the main target species cover the entire Java Sea, always near island groups, and also parts of Makassar Strait and Karimata Strait (see Fig. 11; the match with the results of *R/V Lemuru* is very high). Indeed, the so-called "triangle", the area off southeastern Sumatra reported to be avoided by *layang* (Hardenberg 1937, 1938) is also avoided by the vessels. The seasonalities noted by Hardenberg (1937, 1938) also appear clearly in the purse seine fisheries: peak landings occur in October, while the lowest landings occur around May (Fig. 11, insert).

Thus, while the surveys of *R/V Lemuru* may not have had much influence on the actual development of the pelagic fisheries in Indonesia, they show clearly that it was possible to obtain a good idea of the distribution and relative abundance of the pelagic resources even with the equipment then available. Acoustic surveys with modern echo integrators should thus be, nowadays, even more appropriate to monitor these important resources.

Acknowledgements

This paper came into being thanks to the tireless efforts of Daniel Pauly in documenting research work done in tropical areas. I am very grateful for the opportunity he has offered me to bring to light the results of a major research effort - a fitting expression of our friendship, which, incidentally, began at the Marine Fisheries Research Institute, Jakarta, in mid-1975.

Due to time constraints and distance, this paper was put together by a single author, yet it is based mainly on the work of a number of Indonesian fishery biologists, mentioned above, who are still pursuing the task of assessing the pelagic stocks of Indonesia. I am sure that Bjφrn Bjarnason and José Almenar Sansaloni, respectively Captain and Chief Engineer of *R/V Lemuru*, will also be happy to see some results of their efforts in print.

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Demersal Fish Assemblages of Trawlable Grounds off Northwest Sumatra

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BIANCHI, G. 1996. Demersal fish assemblages of trawlable grounds off northwest Sumatra *[Kelompok ikan-ikan demersal di daerah penangkapan trawl di sekitar barat laut pulau Sumatra]*, p. 123-130. *In* D. Pauly and P. Martosubroto (eds.) Baseline studies of biodiversity: the fish resources of Western Indonesia. ICLARM Stud. Rev. 23, 312 p.

Abstract

Bottom trawl stations from the shelf and upper slope off northwest Sumatra (Indonesia) were analyzed by means of multivariate analysis techniques (detrended correspondence analysis and two-way indicator species analysis) in order to find patterns of zonation among the demersal megafauna assemblages. Apart from the obvious difference between the shelf and slope assemblages, evidence was found for the presence on the shelf of two main species groups, which could partly be explained by a depth gradient. Species composition, with a high percentage of snappers (Lutjanidae) and ponyfishes (Leiognathidae), suggests that, at the time of the survey, the communities in the area were lightly exploited.

Abstrak

Analisis dilakukan terhadap stasiun pengamatan trawl dasar di daerah paparan dan lereng bagian atas di perairan barat-laut Sumatra (Indonesia) dengan teknik analisis multivariate (detrended correspondence analysis dan analisis spesies indikator dua arah) dengan tujuan mencari pola zonasi diantara kelompok fauna besar demersal. Disamping adanya perbedaan nyata antara kelompok fauna di daerah paparan dan lereng, terbukti bahwa sebagian keberadaan dua grup spesies utama terkait dengan tingkat kedalaman. Komposisi spesies, dengan persentase tinggi antara lain ikan kakap merah (Lutjanidae) dan peperek (Leiognathidae), menunjukkan bahwa pada saat survei, tingkat eksploitasi komunitas di daerah survei hanya sedang-sedang saja.]

Introduction

As part of an investigation program of the marine resources of Southeast Asia, the Norwegian research vessel *Dr. Fridtjof Nansen* surveyed the north and northwest coasts of Sumatra between 6 and 30 August 1980. To the author's knowledge no investigation of this type had previously been performed in this area (see also Longhurst and Pauly 1987).

Basic survey results, including biomass estimates for demersal and pelagic stocks, as well as a description of the environmental conditions (hydrography and nutrients) were presented by Aglen et al. (1981). Based on the species composition recorded from the bottom trawl sampling and information on the environmental conditions at each station, an attempt is made here to identify patterns in the distribution of the various species and correlate these with the available environmental information. Because of the very limited coverage in time and space of this survey, the results should be considered as a low-resolution "snapshot" of the demersal assemblages in this area.

This study may be seen as a contribution to "landscape ecology", a relatively new discipline that is distinguished from traditional ecological studies, which usually assume that systems are spatially homogeneous. Landscape ecology stresses that widely used generalizations like "tropical seas" or "tropical communities" do not do justice to the variety of combinations of oceanographic conditions, bottom types and zoogeographic patterns that occur on the ground. Identification and typification of the communities living in well defined "ecological units" will provide a better basis both for understanding the underlying ecological processes and better operational units for management. This will probably involve the definition of broad-scale indices of "landscape" structure which will eventually allow the definition of an appropriate metric for monitoring regional ecological changes. Basic information required will involve definition of appropriate ecological units in terms of physical and biological characterization. The biological characterization should involve among other things species composition, size-spectra, and measures of natural and anthropogenic changes.

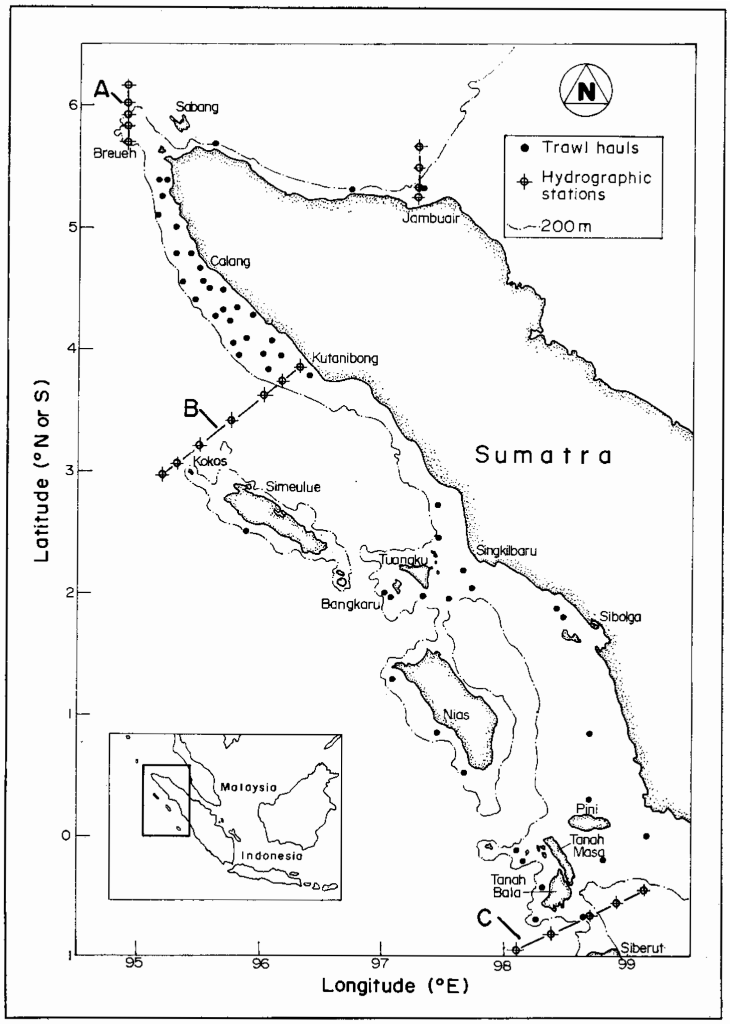

Fig. 1. Position of trawl hauls and hydrographic stations, August 1980.
[Gambar 1. Posisi stasiun trawl dan hidrografi, Agustus 1980.]

The specific objective of this study was to detect the presence of large-scale trends in the occurrence of fish, cephalopods and other nektonic animals in the trawl catches and from this, to infer zonation among those groups.

Materials and Methods

The area covered by this study includes the north and west coasts of Sumatra, from its northern tip to about 1°S (Fig. 1).

In the north, the shelf is very narrow and steep, and thus trawling was very limited. The two large islands of Simeulue and Nias off the northwest coast also have narrow shelves and are, therefore, mostly untrawlable. These islands are separated from the Sumatra shelf by deep basins, except for a narrow connection between Nias and the Sumatra shelf. The northwest coast of Sumatra has a wider shelf with trawlable grounds and most of the samples analyzed here were taken in this area.

The west coast of Sumatra is subject to the monsoon gyre circulation system of the northern Indian Ocean (Wyrtki 1973; Roy, this vol.; Sharp, this vol.). During the northeast monsoon, from November to April, prevailing currents in the northern part of the Indian Ocean are from east to west, but the drift appears to be rather shallow and to exert little influence below the thermocline. During the southwest monsoon (May to October), the main circulation is opposite, and the general movement is eastward. On the other side of the northern Indian Ocean, off Somalia, the waters flow northward, resulting in a well known, strong upwelling. Off Sumatra, the monsoon current flows southward, crosses the Equator, then turns into the South Equatorial Current, thus closing wind-driven gyre of the Equatorial Indian Ocean. Further, during the southwest monsoon, low-salinity water from the Bay of Bengal flows to the southeast along the west coast of Sumatra where the salinity is further reduced by high rainfalls.

Hydrographic sections carried out in the course of the *Dr. Fridtjof Nansen* survey (Aglen et al. 1981) show the presence of a pronounced thermocline between 100 and 125 m. Above the thermocline the mixed layer is rather homogeneous, with temperatures of 28-29°C throughout. Salinity is low, about 33 ppt, which can be explained by the circulation pattern described above. Surface salinity increases southwards to values above 34 ppt off Siberut. Oxygen levels are rather high throughout the shelf and values below 1 $ml \cdot l^{-1}$ are found only below 200 m depths (Fig. 2).

In the course of the same survey, nutrient analyses (phosphate, nitrate and silicate) were also performed. These showed that, above the thermocline, the water masses were almost depleted of nutrients, possibly due to the lack of exchange with deeper and richer water layers.

A total of 49 trawl hauls were performed with a bottom trawl whose codend had 2-cm meshes (stretched), but whose effective mesh size was smaller, because it was double-lined. Fig. 1 shows the position of sampled trawl and hydrographic stations, while Table 1 shows the number of stations by depth stratum and the area of each stratum. The uneven sampling distribution is due to varying bottom conditions in the above strata.

As a first step, all trawl data, covering 337 species, were entered in the NAN-SIS software package of Strφmme (1992), which can be used, among other things, for creating files for analysis using various multivariate methods (see Torres et al., this vol.)

These methods included two-way indicator analysis (TWIA, Hill 1979) and an ordination technique, detrended correspondence analysis or DCA (Hill and Gauch 1980), implemented by the program DECORANA. These methods, originally developed for floristic studies, have proven to be very useful also in marine faunistic studies (McManus 1985, 1989; Bianchi 1991, 1992; Federizon 1992).

Table 1. Number of sampled bottom trawl stations.
[Tabel 1. Jumlah stasiun trawl dasar yang diambil contohnya.]

Depth range (m)	No. of hauls	Area (nm^2)
10-25	8	7,350
26-50	18	9,800
51-75	13	4,900
76-99	9	2,450
100-199	4	-
≥ 200	-	-

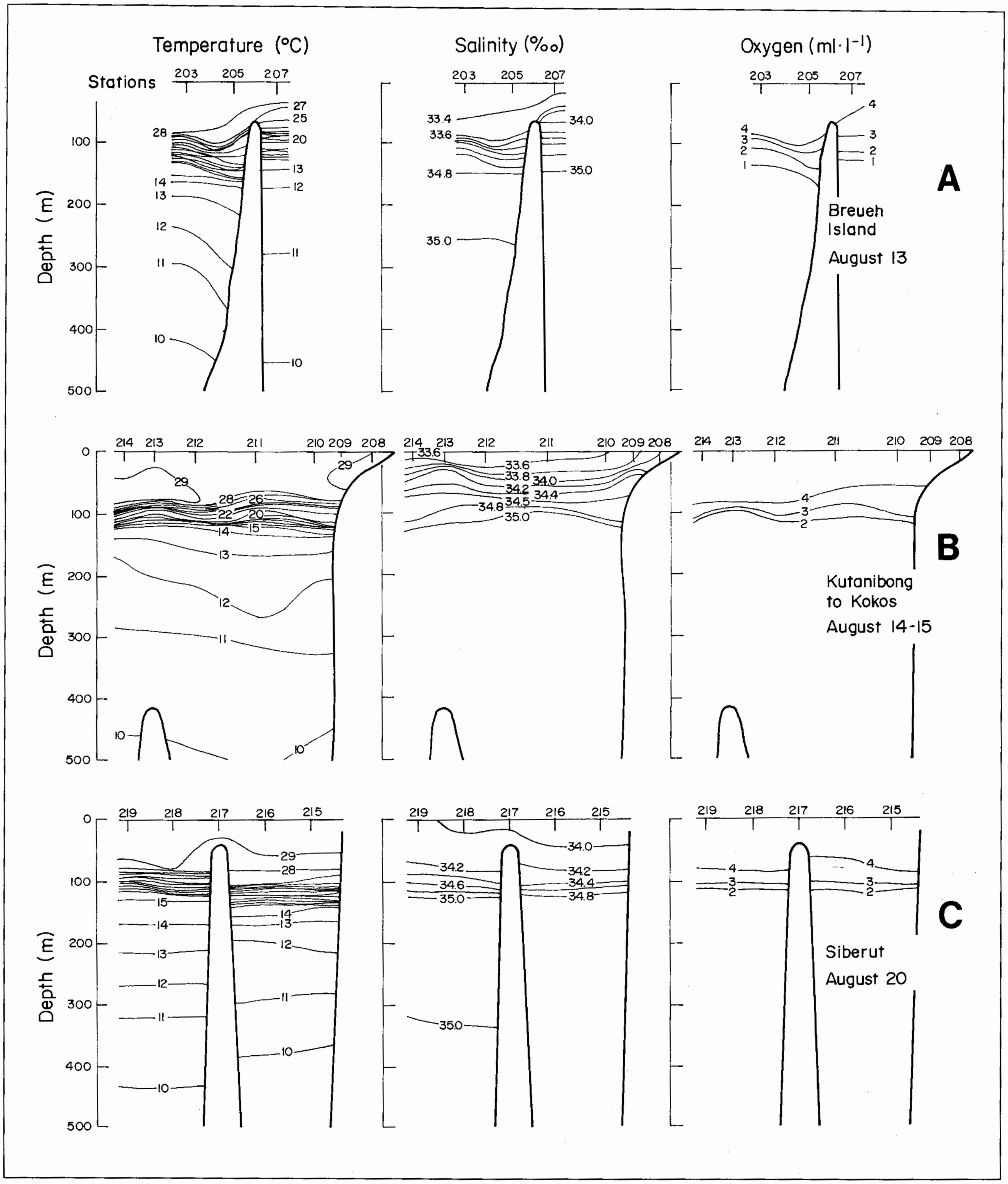

Fig. 2. Hydrographic profiles of temperature, salinity and oxygen at selected places: a) Breueh, 13 August; b) Kokos, 14-15 August; Siberut, 20 August.

[Gambar 2. Profil hidrografi dari suhu, salinitas dan oksigen di tempat-tempat tertentu: A) Breueh, 13 Agustus; B) Kokos, 14-15 Agustus; C) Siberut, 20 Agustus.]

In this study biomass (wet weight) was used as a measure of abundance. Biomass seems to be ecologically appropriate and can be more relevant for practical applications, as for example, for management-orientated studies of fisheries resources. Also, as shown in Bianchi and Høisæter (1992), overall ecological typification is not affected by the abundance measure used by DCA and TWIA when analyzing data covering long gradients.

Each weight ($\underline{x}$) was converted to $\ln(\underline{x}+1)$ before analysis with DCA. This transformation minimizes the dominant effect of anomalous catches, while the addition of 1 unit is necessary to avoid problems related to the log transformation (required by the presence of zero records). No transformation is necessary in the case of TWIA, where abundances are converted to numbers corresponding to different abundance classes ("pseudospecies"). In this study, five "pseudospecies" were used, corresponding to classes with lower limits set at 0, 0.5, 5, 50 and 100. These cutoff levels are lower than those used in previous studies (Bianchi 1991, 1992) but they are appropriate, due to the lower fish abundances of the south-west Indian Ocean as compared with the areas covered in the earlier studies.

Depth and bottom type were used in the analysis to study the main gradients along which community changes take place. Temperature, oxygen and salinity were not included. In fact, as the bottom trawl stations performed in the course of the *Dr. Fridtjof Nansen* survey were all shallower than 100 m (except for a few carried out on the slope), the physical oceanographic parameters were nearly constant, i.e., did not provide environmental gradients in the sampled area.

Bottom type information was derived from the echo-traces along the cruise tracks and classified, according to its suitability for bottom trawling, into three categories: even/flat, uneven and rough bottom. This is a gross classification but it was found

Table 2. Two-way station by *Taxon* table resulting from the program TWINSPAN. Values denote abundance categories: 1: *W*< 0.5 kg; 2: 0.5≤ *W*< 5 kg; 3: 5≤ *W*< 50 kg; 4: 50≤ *W*< 100 kg; 5: *W* ≤ 100 kg.
[Tabel 2. Stasiun (two-way) berdasarkan tabel Taxon diturunkan dari program TWINSPAN. Angka menunjukkan kategori kelimpahan: 1: W<0.5 kg; 2: 0.5<W<5 kg; 3: 5<W<50 kg; 4: 50<W<100 kg; 5: W<100 kg.]

Taxon	1	2	3	4
Abalistes stellatus	——1—13-2—2211—	41-2-2	————————	——
Alepes djedaba	————————	———	-11-2—111-14-1—	——
Arius thalassinus	——————2——	3-21—	—14-13———	——
Carangoides armatus	——1—1———	11—3	——11———31-1	——
Carangoides malabaricus	———1-2-23-25-1-1-	412355	-1-5-12———1—1	——
Carcharhinus sealei	————————	—332	-33—4———12—	——
Centrophorus sp.	————————	———	————————	5534
Chlorophthalmus agassizi	————————	———	————————	5123
Dactyloptena orientalis	-1——121—12-11—	-1——	————————	——
Diagramma pictum	-2—————3———	312—2	1———————	——
Fistularia sp.	———112-1-21-1——	-1113-	————————	——
Gazza minuta	————————	-21-45	—13—4—1—1-1—	——
Gymnocranius grandoculis	22—5—1———3—	4——1	————————	——
Harpadon nehereus	————————	—2—	-1—21————531	—1
Jellyfish	————————	———	—4————5555—	——
Lactarius lactarius	————————	1-1-51	1-35113—1-11331-1	——
Leiognathus bindus	———1——————	—1555	4115—4111115-231-	——
Leiognathus equulus	———————— —	-43-52	5-35-221—15-21—	——
Leiognathus fasciatus	————————	-5—44	-1———————	——
Leiognathus leuciscus	———1——————	—1-42	———1—1—1-2—	——
Leiognathus splendens	———1——————	-14-52	-1145431-1—1-5—	——
Loligo sp.	——1121-1-11-111—1	-111—	———111——12—	1-1-
Lutjanus erythropterus	——2-15—534-4-2—	413533	———————4-	——
Lutjanus malabaricus	————51——3—24—	———	————————	——
Myctophidae	————————	———	————————	1113
Opisthopterus tardoore	————————	———	2-1-2—1——2—2-1	——
Parastromateus niger	————————	———	—14—3—11—1-1—	——
Pellona ditchela	————————	3-1-52	1-15—3—1——1—	——
Pentaprion longimanus	———431-12-23-1—	14-151	-1-1——1——1—	——
Peristedion sp.	————————	———	————————	3111
Polynemus sextarius	——————1———	211-5-	—121-2—————	——
Pomadasys argyreus	——————1———	-13-5-	51552432——1-3-3	——
Pomadasys maculatus	———1-1——1———	413-4-	—14—————1—	——
Priacanthus tayenus	———31—1—32-2—	-3——	-1———————	——
Pristipomoides typus	——53-34—3—35—	———	————————	——
Rastrelliger brachysoma	——————1——	—1—	—1-1—15——13—	——
Saurida tumbil	———1-3—1-23-1—	1514—	2341245—1———1	——
Saurida undosquamis	——11112-1111111—	———	————1————	-1—
Scomberomorus guttatus	————————	——4	4-252-43-2—522—	——
Secutor insidiator	————————	—1—2	—1111-112-1—3—	——
Selar crumenophthalmus	—1——————2-	—3-53	1——5—21—1—	——
Sphyraena barracuda	—2—————1———	-51—	——————411—	——
Sphyraena obtusata	————————	-14-5-	—15—5———1—	——
Terapon theraps	———111——1———	11115-	21322-1111—1—21-	——
Thenus orientalis	—11——1—1———1—	13-1—	———————1—	——
Thyrsitoides sp.	————————	———	————————	2112
Trichiurus lepturus	————1——1———	215-5-	4-541-55-1-1-22411	1—
Upeneus moluccensis	——1—11—1—22-1—	21-1-1	-1———————	——
Upeneus sulphureus	———1——————	-24351	24252141-1——1—1	——

useful and used in the assemblage-environment correlation analysis. As bottom type is a nominal variable, this had to be transformed in order to allow statistical analysis. This was done by coding each class as a separate variable as suggested in Ter Braak (1987).

Catch rates by depth stratum and average weight were calculated using NAN-SIS (Strϕmme 1992).

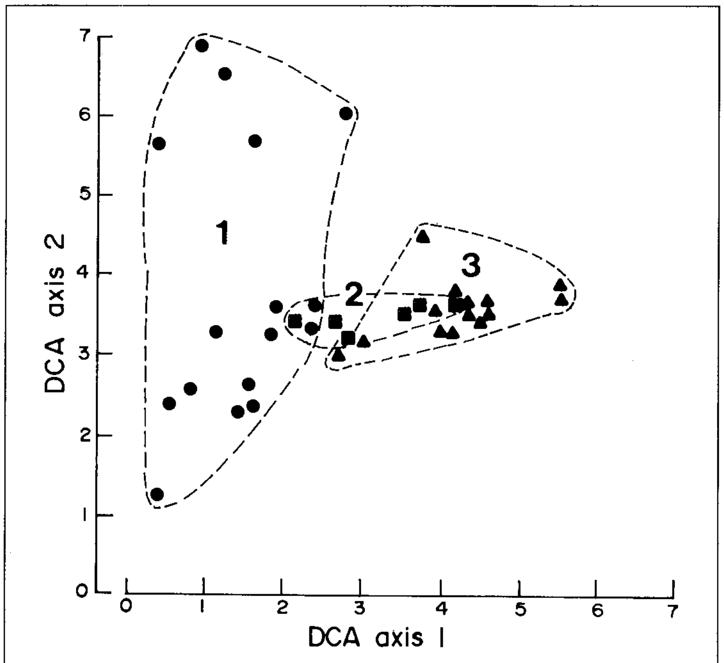

Fig. 3. DCA of bottom-trawl stations on the shelf. The corresponding TWIA Groups (1 to 3) can be recognized by different symbols.
[Gambar 3. DCA dari stasiun trawl dasar di daerah paparan. Kelompok TWIA (1 hingga 3) ditampilkan dengan simbol yang berbeda.]

Table 3. Pearson product-moment correlation coefficient between sample scores on DCA (detrended correspondence analysis) Axes 1 and 2 and environmental variables for shelf stations, Sumatra, August 1980 survey. Values with asterisk indicate significant correlation ($p < 0.05$, df: 42).
[*Tabel 3. Koefisien korelasi* product-moment *Pearson antar nilai contoh pada DCA sumbu 1 dan 2 serta variabel lingkungan untuk stasiun-stasiun di paparan, Sumatra, survei bulan Agustus 1980. Nilai dengan tanda bintang menunjukkan korelasi nyata (p<0.05, df: 42).]*

Variable	Axis 1	Axis 2
Depth	-0.77*	-0.39*
Even	0.39*	0.15
Uneven	-0.23	-0.15
Rough	-0.28	-0.04

Results

Table 2 presents a summary of the TWIA output, where the trawl stations (represented by columns) are grouped according to their species composition. (All species caught were included in the analysis but only the 50 commonest are presented in Table 2; see Torres et al. (this vol.) for details on a file with the complete list). Four major groups of stations are evident, each with a characteristic species composition. The dendrogram at the bottom of the table shows the hierarchical relationship between these groups, based on species composition. The first division separates the four slope stations from the shelf stations. None of the typical slope species are found on the shelf. Indicator species are the greeneyes (*Chlorophthalmus agassizi*) and the deepwater shark (*Centrophorus* sp.). The second division marks two main groups, one characterized by the lizardfish (*Saurida undosquamis*) and several snapper species (Group 1) and the other by a number of ponyfishes, Family Leiognathidae, the false trevally, *Lactarius lactarius*, the hairtail *Trichiurus lepturus* (Groups 2 and 3). Group 2 represents an intermediate association, with species of Groups 1 and 3. A few taxa appear to be ubiquitous, i.e., *Loligo* spp., *Saurida tumbil* and *Carangoides malabaricus*. It was not considered meaningful

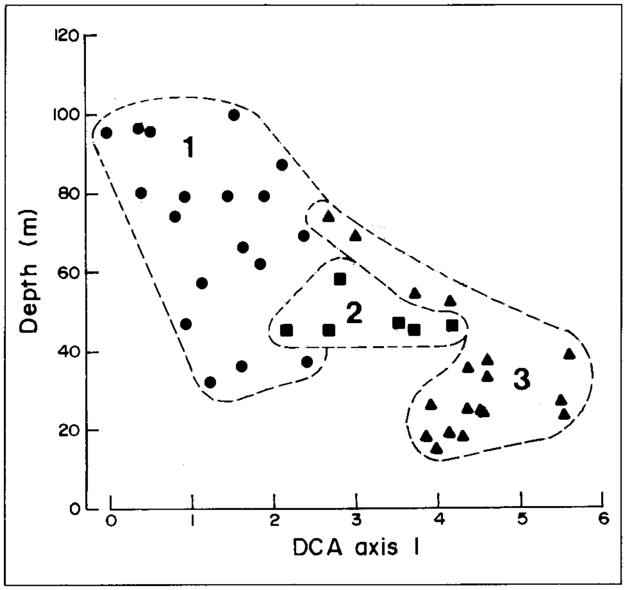

Fig. 4. Plot of station scores on DCA, Axis 1 against depth. Corresponding TWIA Groups (1 to 3) can be recognized by different symbols.
[Gambar 4. Plot nilai stasiun pada DCA, Sumbu 1 terhadap kedalaman. Kelompok TWIA (1 hingga 3) ditampilkan dengan simbol yang berbeda.]

Table 4. Average values and standard deviation (s.d. in brackets) for environmental variables used in the analysis, for each of the groups identified by TWIA (n.a. = not available).
[Tabel 4. Nilai rata-rata dan simpangan baku (s.d.) untuk variabel lingkungan yang digunakan didalam analisis, untuk setiap grup berdasarkan TWIA (n.a. = tidak ada data).]

	Group 1 (n=19)	Group 2 (n=6)	Group 3 (n=18)	Group 4 (n=4)
Depth (m)	67 (19)	47 (4)	30 (14)	298 (30)
Even bottom (%)	0.66 (0.47)	0.36 (0.48)	0.89 (0.3)	n.a.
Uneven bottom (%)	0.33 (0.47)	0.26 (0.44)	0.11 (0.3)	n.a.
Rough bottom (%)	0	0.37 (0.48)	0	n.a.

to analyze further divisions due to the small number of available stations.

Fig. 3 shows the results from the analysis using DCA. The groups identified by TWIA are also shown, with exception of the four slope stations, which were excluded to allow better resolution of the plot for the shelf stations. Table 3 shows the results from the correlation between the ordination axes and the values of the environmental variables available for each station. The highest correlation was found between Axis 1 and depth (r = 0.77). A positive and significant correlation is also found between Axis 1 and even bottoms, suggesting that the bottom was more even in the shallow than in the deeper part of the shelf. Stations of Group 1 show a great spread along Axis 2 indicating that one or more sources of residual variation are present. Table 4 shows the average values for the bottom characteristics, for each of the groups, confirming the decreasing trend in depth from Groups 1 to 3 (67, 47 and 30, respectively). Highest percentage of bottom type classified as even is found in Group 3, the shallowest, while rough bottoms were classified only in stations of Group 2.

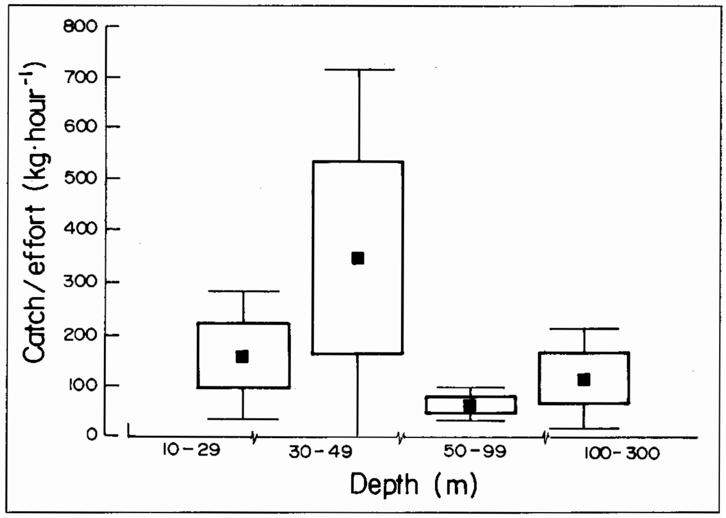

Fig. 6. Box and whisker plot for CPUEs in each depth stratum: 1: 10-30 m; 2: 30-50 m; 3: 50-100 m; 4: (100-300 m). Small square: mean CPUE; box: ±1.00 SD; whisker: ±1.96 SD.

[Gambar 6. Boks dan whisker plot dari CPUE di setiap strata kedalaman: 1: 10-30 m; 2: 30-50 m; 3: 50-100 m; 4: 100-300 m. Kotak kecil: CPUE rata-rata; boks: ±1.00 SD; whisker: ±1.96 SD.]

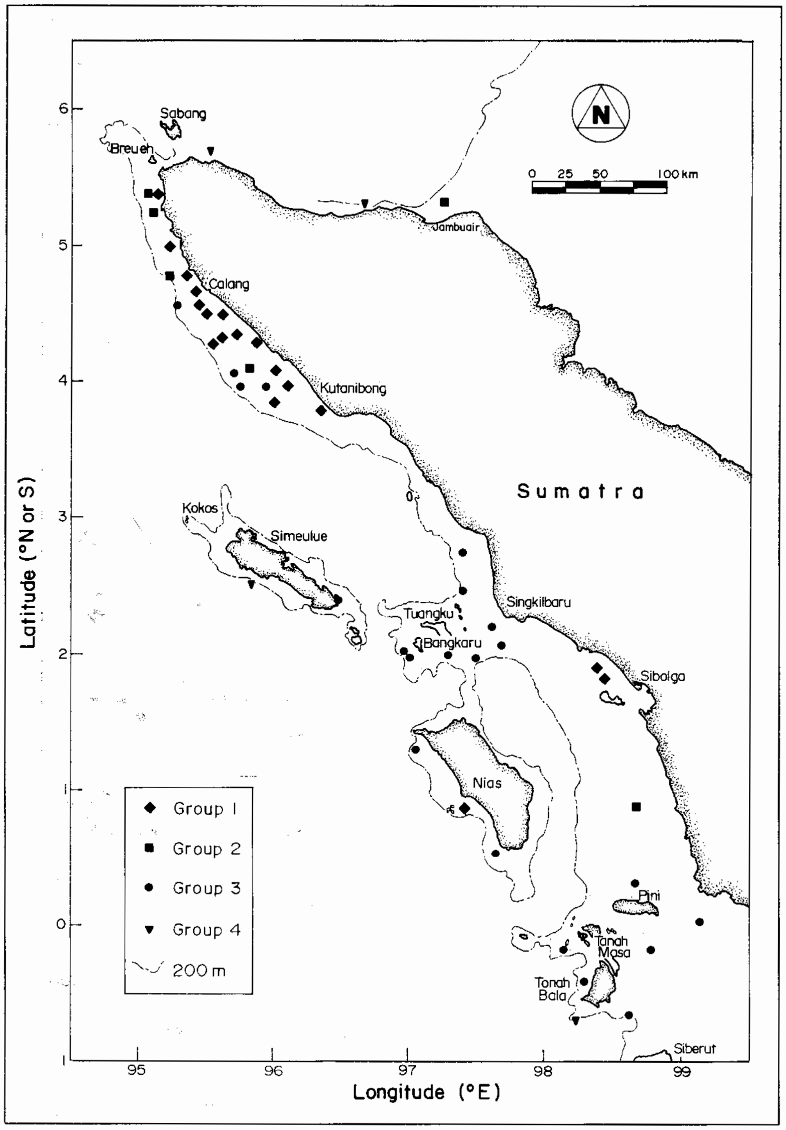

Fig. 5. Map showing position of trawl stations after having been assigned to the different groups. Divisions based on TWIA divisive clustering.

[Gambar 5. Peta posisi stasiun trawl setelah dilakukan pengelompokan berdasarkan grup yang berbeda. Pembagian grup dilakukan berdasarkan teknik TWIA divisive clustering.]

Fig. 4 shows a plot of DCA Axis 1 against depth, the thick line representing the first TWIA division of the shelf stations. Although the correlation with depth is evident, there is a wide spread in depth values especially within Group 1 and Group 3. Unfortunately, detailed environmental information is not available which could be used to interpret these results. In particular, the classification of bottom type (even, uneven, rough) is probably too coarse. For example, the category "even" includes bottoms ranging from sandy to muddy and, i.e., bottom types usually associated with different taxa.

Fig. 5 shows the trawl stations represented by different symbols depending on which group they belong to. The leiognathid assemblages (2 and 3) are the most coastal ones, being located mainly on the shallower part of the shelf. The snapper/lizardfish assemblage is found in the deeper part of the northern shelf and in the southern part of the sampled area.

Table 5 shows the relative abundances of the dominant species in each of the groups. In the deepest group (Group 1), snappers represent 32% of total biomass, while in Groups 2 and 3 ponyfishes represent 53 and 21%, respectively, of the total biomass.

Fig. 6 shows the relative abundances by depth stratum. Highest abundances on the shelf were found between 30 and 50 m, and the lowest were between 50 and 100 m.

Discussion

Apart from the very obvious difference between the shelf and slope assemblages, there is evidence for the presence on the shelf of two main assemblages, which could partly be explained by a depth gradient. Thus a shallow, leiognathid assemblage could be defined, as well as a deeper snapper-lizardfish group (*S. undosquamis*). The two overlap at about

Table 5. Total catch, catch/effort and contribution to the catches for main species in station groups 1 to 4. Catch/effort = total weight caught/number of station in each group.
Tabel 5. Hasil tangkapan total, hasil tangkapan per upaya dan kontribusi terhadap hasil tangkapan untuk spesies utama dalam grup 1 hingga 4. Hasil tangkapan per upaya = jumlah berat total hasil tangkapan dibagi jumlah stasiun di setiap grup.]

Species	Total (catch) (kg)	Catch/effort ($kg \cdot hour^{-1}$)	Proportion (%)	(Σ%)
Group 1 (19 stations)				
Abalistes stellatus	19.6	1.0	2.3	50.0
Carangoides malabaricus	40.9	2.1	4.7	42.0
Gymnocranius grandoculis	30.0	1.6	3.4	45.4
Loligo sp.	4.9	0.3	0.5	54.5
Lutjanus malabaricus	73.1	3.8	8.4	32.3
Lutjanus sanguineus	120.6	6.3	13.8	13.8
Nemipterus tambuloides	7.6	0.4	0.9	54.0
Pentaprion longimanus	43.4	2.3	5.0	37.3
Priacanthus tayenus	17.4	0.9	2.0	52.0
Pristipomoides typus	88.6	4.7	10.1	23.9
Saurida tumbil	19.9	1.4	2.3	47.7
Saurida undosquamis	10.0	0.5	1.1	53.1
Others (comprising 124 taxa)	398.2	19.9	45.5	100.0
Total	874.2	46.0	100.0	
Group 2 (6 stations)				
Carangoides malabaricus	109.8	18.3	2.6	67.7
Gazza minuta	122.3	20.4	2.9	62.5
Leiognathus bindus	692.6	115.4	16.3	46.5
Leiognathus equulus	112.7	18.8	2.6	65.1
Leiognathus fasciatus	50.0	8.3	1.2	72.7
Leiognathus splendens	1,286.0	214.3	30.2	30.2
Lutjanus malabaricus (non *sanguineus*)	74.8	12.5	1.7	71.5
Pellona ditchela	31.5	5.3	0.8	74.3
Pentaprion longimanus	91.0	15.2	2.1	69.8
Pomadasys argyreus	138.9	23.2	3.3	59.6
Pomadasys maculatum	32.5	5.4	0.8	73.5
Trichiurus lepturus	196.9	32.8	4.6	56.3
Upeneus sulphureus	221.2	36.9	5.2	51.7
Others (comprising 117 taxa)	1,096.1	182.7	25.7	100.0
Total	4,256.3	709.4	100.0	
Group 3 (18 stations)				
Lactarius lactarius	85.4	4.7	2.7	40.5
Leiognathus bindus	192.6	10.7	6.1	26.2
Leiognathus equulus	348.7	19.4	11.1	11.1
Leiognathus splendens	101.9	5.7	3.2	37.8
Pomadasys argyreus	155.7	8.6	5.0	31.2
Saurida tumbil	72.1	4.0	2.4	42.9
Scomberomorus guttatus	106.6	5.9	3.4	34.6
Terapon theraps	26.8	1.5	0.9	45.4
Trichiurus lepturus	282.2	15.7	9.0	20.1
Upeneus sulphureus	47.0	2.6	1.6	44.5
Others (comprising 134 taxa)	1,710.3	95.0	54.6	100.0
Total	3,129.3	173.9	100.0	
Group 4 (4 stations)				
Centrophorus sp.	109.0	27.3	20.0	20.0
Chlorophthalmus agassizi	45.0	11.2	8.2	44.8
Peristedion sp.	7.6	1.9	1.4	47.6
Shrimp	90.7	22.7	16.6	36.6
Thyrsitoides sp.	8.0	2.0	1.4	46.2
Others (comprising 70 taxa)	286.8	71.7	52.4	100.0
Total	547.1	136.8	100.0	

40 m. However, depth does not seem a satisfactory variable when considered alone. In fact, as shown in Fig. 4, all three groups have representatives in comparable depth ranges, at least for depths less than about 70 m. Each group also includes stations that do not conform with the general trends. It is thus possible that our trawl stations sampled fish from specific biotypes that were overall not well represented, because of the gear used and/or the sampling design. Bottom type usually is the next important variable, in uniform waterbodies, but no detailed information was available. Federizon (1992) found, for example, that in the central Philippines, two assemblages associated with coralline and sandy substrates of the same depth could be separated.

However, the assemblages defined above appear to be meaningful. Previous studies of this type in Southeast Asia show in fact comparable results. McManus (1985, 1986) reported on a study on the assemblages of the Samar Sea, based on 28 stations at depths of about 10 to 100 m and thus comparable with the shelf stations of the present study. He found a main depth boundary at 40 m, with a shallower community dominated by two leiognathids, while the deeper (> 40 m) community was characterized by *S. undosquamis*, as also found here. However, while his accompanying species are similar, their relative abundances were different. In particular, the snappers are an important element of assemblages 1 and 2 in our study, but do not appear in the deeper assemblage from the Samar Sea, where in the late 1970s trawl fishing had been banned because of overexploitation (Saeger 1981). Thus it is easy to speculate that the scarcity in the Samar Sea, of these highly-priced, long-lived species might be due not to ecological differences, but to the effects of high fishing pressure on community composition. Conversely, this would suggest that in 1980 the fish communities in the *R/V Dr. F. Nansen* survey area were not heavily exploited. A similar suggestion is derived by comparing our results with those of Pauly (1979) and Suvapepun (1991) from the Gulf of Thailand. In this area the dominant group in the trawl catches in the 1960s were leiognatids, followed by a number of groups similar to those found off Sumatra. By the end of the 1970s, the leiognathids, the false trevally (*Lactarius lactarius*) and snappers had disappeared in the Gulf of Thailand from the list of the top 20 species, while squid (*Loligo* sp.) had become very abundant. The species composition off the northwest Sumatra shelf in 1980 suggests that exploitation in this area had not reached those levels. This is also confirmed by the biomass estimate of demersal fish derived from the *Dr. Fridtjof Nansen* survey, of 90 x 10^3 t (Aglen et al. 1981), which is rather large relative to the estimated catches for that region, for the period 1976-1977, i.e., only about 13 x 10^3 t·year^{-1}.

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Narrative and Major Results of the Indonesian Module (I) of the JETINDOFISH Project, November 1980 to October 1981

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Abstract

An account is presented of Indonesian trawl survey cruises conducted from November 1980 to October 1981 in the framework of the multiagency "Joint Eastern Indian Ocean Fisheries Survey" (JETINDOFISH). The area surveyed - mainly through demersal trawling - ranged from east of 115°E to 120°E, and covered the shelf off Lombok, Sumbawa, Sumba, Flores and Timor.

Abstrak

Sekilas disajikan hasil pelayaran survei trawl yang dilaksanakan oleh Indonesia dalam rangka kerjasama Proyek JETINDOFISH sejak November 1980 hingga Oktober 1981. Daerah yang disurvei - khususnya dengan trawl dasar - mencakup wilayah perairan dari sebelah timur pada 115°BT hingga 120°BT, dan meliputi daerah paparan di sekitar Lombok, Sumbawa, Sumba, Flores dan Timor.

Introduction

The paper summarizes the trawl surveys conducted as part of "Module I" of the "Joint Eastern Indian Ocean Fisheries Survey" (JETINDOFISH). The surveys of Module I were conducted in the southeastern part of Indian Ocean, i.e., in the vicinity of Lombok, Sumbawa, Sumba, Flores and Timor (Fig. 1). These surveys were conducted in the context of a project of the Government of Indonesia (through the Directorate General of Fisheries), the Federal Republic of Germany (through the Deutsche Gesellschaft für Technische Zusammenarbeit [GTZ]) and the Commonwealth Government of Australia (through the Common Scientific and Industrial Research Organisation [CSIRO]), under the coordination of FAO. GTZ provided financial assistance and experts for the survey of Module II which covered the area from west of Sumatra to south of Bali, while Australia conducted a survey (Module III) in the northwestern shelf of Australian continent (see Lohmeyer, this vol.).

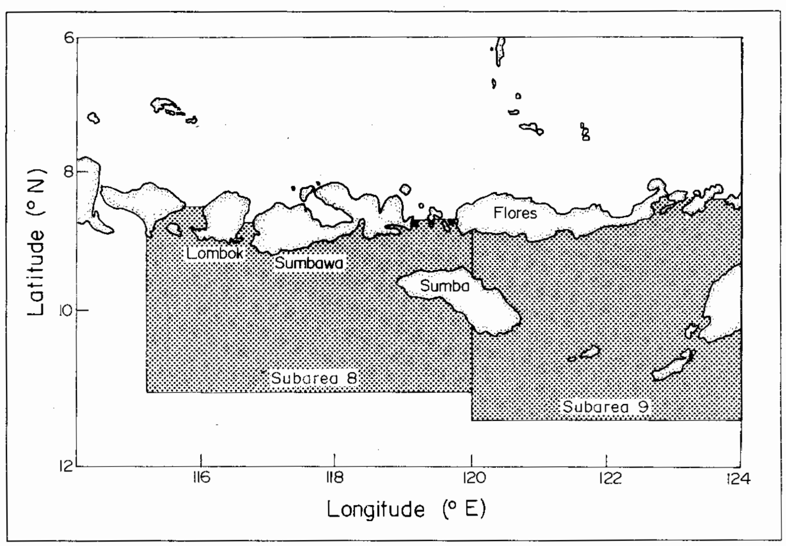

Fig. 1. Area covered by the *Bawal Putih 2* surveys, and consisting of subarea 8 (South of Lombok and Sumbawa, and west of Sumba) and (south of Flores), details on each haul one given in the database documents by Torres et al. (this vol.) *[Gambar 1. Daerah yang disurvei kapal* Bawal Putih 2 *yang meliputi subarea 8 (bagian selatan Lombok dan Sumbawa serta bagian barat Sumba) dan subarea 9 (bagian selatan Flores), rincian tiap tarikan trawl terdapat dalam dokumen Torres et al. (dalam buku ini).]*

Box 1. Vessel specifications of *R/V Bawal Putih 2.*
[Box 1. Spesifikasi kapal Bawal Putih 2.*]*

Type: stern trawler

Main dimensions:

Length O.A.		36.0 m
Length B.P.P.		30.0 m
Breadth MLD		9.4 m
Tonnage:	GRT	370.3 t
	NRT	115.5 t

Engine specifications:

1.	Main engine (1)	:	Caterpillar D 399
	No. of cylinder	:	16
	High idle engine RPM	:	1,345
	Pull load engine RPM	:	1,200
	HP at sea	:	1,125
2.	Auxillary engine (2)	:	Yanmar D 6 KFL
	HP	:	170

The Surveys

The surveys of Module I were conducted by the *R/V Bawal Putih 2*, a stern trawler of 350 GRT owned by the Directorate General of Fisheries (Box 1). The scientific teams and the crew were Indonesian and surveys were conducted independently of those in Modules II and III. However, most activities and sampling protocols were standardized by an Advisory and Technical Committee composed of members of all agencies involved in the JETINDOFISH project, while FAO provided a project coordinating officer at the project office in Denpasar, Bali.

The survey was conducted during the period from November 1980 to October 1981. Owing to limitations of its rigging, the trawling operations of *Bawal Putih 2* were conducted only at depths of less than 100 m. To compensate for this limitation, a small number of hauls at depths of more than 100 m were done by *R/V Jurong* of Module II (see Lohmeyer, this vol.) in July 1981; these covered the shelf of Lombok Island and its vicinity (subarea 8).

A total of eleven cruises was made during the survey period. Two or three biologists and three or four technicians were onboard in each cruise. A FAO associate professional officer (APO) from Denmark on fish taxonomy participated in four of the eleven cruises, to assist the biologists with fish identifications.

The Vessel

The *R/V Bawal Putih 2* is a steel stern trawler of 350 GRT (Box 1), equipped with an Engel-type high opening bottom trawl (Fig. 2). In the absence of acoustic equipment, echotracing for pelagic fish resources could not be performed (but see Venema, this vol. for an echoacoustic survey of the area in Fig. 1). Measurements of oceanographic parameters during the survey were limited to temperature profiles, obtained through bathythermographs.

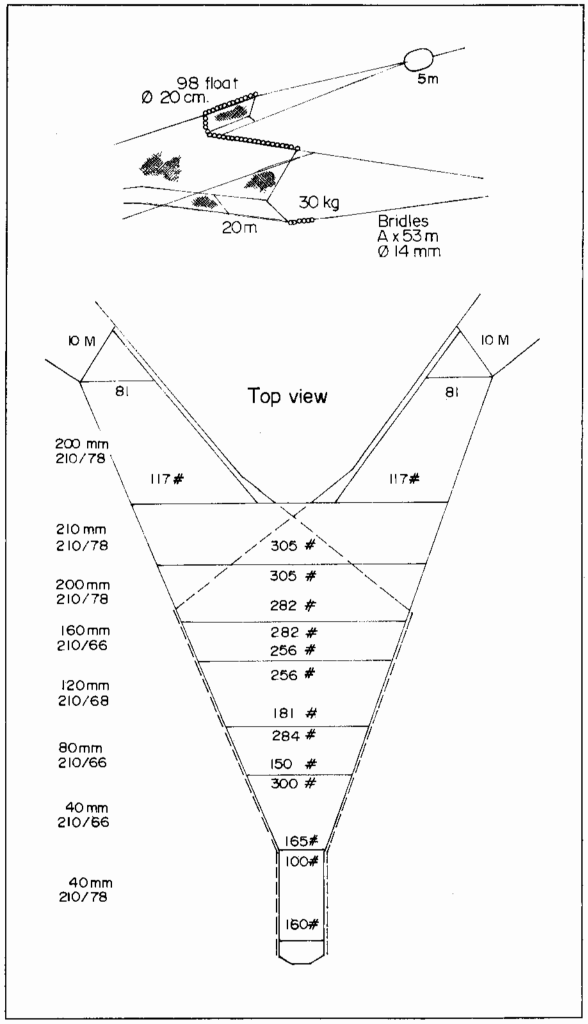

Fig. 2. Technical features of the trawl used during the *Bawal Putih 2* surveys.
[Gambar 2. Gambaran teknis dari jaring trawl yang digunakan dalam survei dengan kapal Bawal Putih 2.*]*

Sampling and Fish Species Identification

Sorting and sampling of the catches were done directly onboard after the catches had been dumped onto the rear deck. The sampling procedures were the same as for the other Modules of the JETINDOFISH project (see Lohmeyer, this vol.).

Shipborne identifications were based on FAO Species Identification Sheets (Fischer and Whitehead 1974) and *"The Fishes of New Guinea"* (Munro 1967).

Results and Discussion

Eleven cruises of *R/V Bawal Putih 2* completed during the survey period resulted in 121 trawl hauls in areas 8 and 9.

Surface temperatures during the survey period ranged from 26 to 30°C, but fell down to a range of 8.5 to 10°C at 300 m.

Table 1. Distribution of average catch rate (C/f; kg·hour^{-1}) and stock density (D, in t·km^{-2}) by subarea (8 or 9), depth and monsoon (east or west monsoon)[a].
[Tabel 1. Penyebaran rata-rata hasil tangkapan per upaya (C/f; kg/jam) dan kepadatan stok (D, dalam t·km^{-2}) berdasarkan subarea (8 atau 9), kedalaman dan monsun (timur atau barat)[a].]

Sub-	Mon-		0-50 m			50-99 m			100-149 m[b]			150-199 m[b]			>200[b]			All depths	
area	soon	N[a]	C/f	D	N	C/f	D	N	C/f	D	N	C/f	D	N	C/f	D	N	C/f	D
8	E	34	251	2.100	46	287	2.991	10	204	2.370	1	31	0.309	2	128	1.215	93	256	2.326
	W	30	264	1.987	16	191	1.778	-	-	-	-	-	-	-	-	-	46	231	1.892
9	E	3	776	5.432	7	320	2.148	-	-	-	-	-	-	-	-	-	10	646	4.493
	W	9	178	1.053	2	411	2.852	-	-	-	-	-	-	-	-	-	11	211	4.500

[a]N = Number of hauls.
[b]Hauls by *FRV Jurong*.

Box 2. Small-Scale Fisheries Development Project in Lombok, Nusa Tenggara Barat, Indonesia.
[Boks 2. Proyek Pengembangan Perikanan Skala Kecil di Lombok, Nusa Tenggara Barat, Indonesia.]

In 1983, the DGF initiated the "Small-Scale Fisheries Development Project on Bali and Lombok" (SSFDP), implemented again with German technical assistance through the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). Because of the comparatively high development of the fisheries around Bali, the project since 1986 concentrated entirely on Lombok and adjacent waters. SSFDP responded directly to the DGF (Resources Management Division) in Jakarta, but was attached to the provincial fisheries office (Dinas Perikanan Tingkat I) in Mataram, Lombok.

In its 10 years of existence (1983-1993), SSFDP went through several phases of organization and implementation, all aimed at promoting employment in and income from small-scale fishing and related fields, while preserving the natural resources. The project staff therefore worked not only on fishing technology, resource monitoring and fish processing, but also considered local social and economic conditions. This entailed extensive training programs for the target fishermen and their wives in organizational, technical and economic aspects.

Central to the project implementation was the support and guidance given to fishing groups established by local fishers from Labuhan Lombok at the east coast of Lombok. Each group consisted of four members, operating a newly designed fishing boat equipped with tuna drift gillnets, acquired on a credit basis. Aside from the formation of 30 fishing groups, the important task was to identify and establish an appropriate organizational framework (a self-supporting or cooperative structure) in order to gain access to the credit program of the Regional Development Bank (Bank Pembangunan Daerah). Due to lack of collateral, credit facilities would not easily be available to individual fishers. Close cooperation was maintained between the fisheries office and the bank, but also with nongovernment organizations (NGOs), especially in the fields of extension and training.

Resource monitoring was the main task of the section of SSFDP devoted to fisheries biology. Target species of the developing tuna drift net fisheries were highly migratory fish, distributed over a much larger area than the actual fishing ground. No stock assessment of the pelagic resources of Alas Strait and adjacent waters was carried out, since this would have been beyond the scope of the project; the chosen approach was therefore to monitor the catch and effort of the developing fishery. Information on yields and catch rates could also immediately be used to formulate extension advice both in technical and economic terms. Dominant target species was skipjack (*Katsuwonus pelamis*) with 54%, followed by frigate tuna (*Auxis thazard*) and kawakawa (*Euthynnus affinis*) with 17 and 7% of the catch, respectively.

The recommended fishing gear was based on a series of fishing gear trials and comparisons with other drift net fisheries south of Java and Sumbawa. Various parameters such as mesh size, fishing (float-line) depth, hanging ratio, trimming, fishing times and increased net length were tested. Since personnel constraints had to be considered in this nonmechanized fisheries, the recommended drift net had a length of about 1,250 m, consisting of 25 single net pieces (nylon multifilament D12-D15) of 50 m each; net depth was around 12 m (140 meshes) with mesh sizes ranging from 10 to 15 cm. Nets drifted near-surface and were set during night time for approximately six hours at a distance of about 30-50 km from the coast. By introducing drift gill nets and motorized fishing boats, SSFDP avoided conflict between the traditional and the newly formed fishing groups. Fishing boats were designed by project staff and produced both by private boat yard and a project run facility, which was later privatized. The boats had a length of 7.6 m, powered by 10-15 hp inboard diesel engines, and were built of fiberglass laminated marine plywood, incorporating a wash deck and insulated fish boxes into the design.

The section of SSFDP devoted to fish processing and marketing tested and introduced improvements in the formulation of traditional products like boiled salted fish (*pindang*), fish floss and fish cracker (*krupuk*). At the same time, attention was also focused on the hygienic aspects of fish handling and the economic aspects of marketing, in order to assure better income not only from increased amounts of fish marketed but also from higher fish prices. SSFDP assisted in the setting up of a functional quality control laboratory at the fisheries office in Mataram. Here, routine control tests such as organoleptic evaluation, chemical and microbiological quality analyses were carried out on fish, invertebrates and processed market products.

Advisory (extension) services to the fishing groups in group formation and management, as well as the development of a financial system for the acquisition of the fishing system was the central task of SSFDP. Group formation involved a stepwise process of application, interview and selection, involving project staff, village leaders and NGOs, as well as a bank representative. Intensive training both ashore and at sea was followed by a practice period, during which a group could use a project owned boat for free, but under supervision. This period served to assess the group's skills and chances of success and to accumulate own funds (collateral) for the downpayment of 10% of the boat price. The credit contract for boat and equipment was signed by all four members. The interest rate for the loan was 12% per year, with a loan period of up to five years. In order to assure a better administrative and legal basis, fishing groups joined together to form a pre-cooperative. Its functions were to solve any coordination problems, make joint purchases and to act as a channel for the credit repayment procedures.

Monitoring was not only extended to the resources, but also the economic and social situation of the individual fishing groups (impact monitoring) and the process of project implementation (activity monitoring). When necessary, training and extension input required was tailored according to needs. Apart from monitoring and evaluation, several other concept elements of SSFDP need to be underlined: activities were designed to stimulate the self-help potential of the target groups, long-term supply and operation of the boats were assured through privatization of boat yard and maintenance workshop, and the viability of the financing concept was established with the credit scheme provided by a local bank.

During the last years of implementation of SSFDP, independent boat owners operating at the east and south coast of Lombok started to equip their units with drift nets recommended by the project, adding 20-30 boats to the SSFDP-assisted fisheries.

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Table 2. Estimate of potential yield by fish category[a] and subarea.
[Tabel 2. Perkiraan potensi hasil tangkapan berdasarkan katagori[a] grup ikan dan subarea.]

Sub-area	Area swept (km^2)	Potential yields ($t \cdot year^{-1}$) A	B	C	D	E	F	Total
8	2,470	1,155	4,977	12,489	36,885	18,300	45,701	119,507
9	800	11,831	142	1,055	14,237	1,858	15,320	44,443
Total	3,270	12,986	5,119	13,544	51,122	20,158	61,021	163,950

[a]A to F are fish categories (see text).

For analysis, the fish catches were grouped as follows (see also Table 1):

A : sharks and rays;
B : sardines *(Sardinella* spp.*)* and anchovies (Engraulidae);
C : Carangidae;
D : Lutjanidae, Sparidae, Lethrinidae;
E : Nemipteridae, Polynemidae, Trichiuridae, Ariidae, Bothidae;
F : Leiognathidae, Gerreidae, Mullidae, Synodontidae

Estimation of fish stock density was based on the swept area method, with an assumed escapement factor of 50%. The potential yield estimation followed the method of Gulland (1971) with an assumed average annual natural mortality of 0.5 $year^{-1}$. As the survey area is under the influence of monsoonal regime (Sharp, this vol.; Roy, this vol.; Venema, this vol.), the catch rates were grouped according to monsoon (east monsoon: April - October, west monsoon: November - March). Table 1 summarizes the distribution of catch rate and of estimated fish stock densities according to monsoon and depth category, while Table 2 presents the estimate of potential yields by fish group and area. The abundance (potential) of group D, the most valuable group of species, is relatively high, as noted during the *R/V Lemuru* surveys (Venema, this vol.)

Overall, the survey did not indicate the area to show a sufficient potential for the development of trawl fisheries; this led to the initiation of a project on small-scale fisheries around Lombok island (Box 2).

Pauly et al. (this vol.) and Torres et al. (this vol.) present further analyses based on the data from the *R/V Bawal Putih 2* surveys, and details on the stations, respectively.

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Fishery Biology of 40 Trawl-caught Teleosts of Western Indonesia[a]

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Abstract

A review of the biology of 40 fish species abundant in bottom trawl catches in Western Indonesia is presented. This emphasizes geographic and depth distribution, based on surveys conducted from 1974 to 1981 by the research vessels *Jurong, Mutiara 4, Dr. Fridtjof Nansen, Lemuru* and *Bawal Putih 2*, and biological information (growth, length-weight relationships, food and feeding habits) estimated from the survey data and/or extracted from FishBase, the computerized encyclopedia of fish.

Abstrak

Tulisan ini menyajikan suatu tinjauan terhadap biologi dari 40 spesies ikan yang banyak terdapat dalam hasil tangkapan trawl di perairan Indonesia bagian barat. Tulisan ini menekankan penyebaran secara geografis dan kedalaman, berdasarkan survei yang dilaksanakan dari tahun 1974 hingga 1981 oleh kapal-kapal penelitian Jurong, Mutiara 4, Dr. Fridtjof Nansen, Lemuru *dan* Bawal Putih 2, *serta informasi biologi (pertumbuhan, hubungan panjang-berat, makanan dan kebiasaan makan) yang diperoleh dari data survei dan/atau diambil dari FishBase, suatu ensiklopedia ikan dalam bentuk perangkat lunak komputer.*

Introduction

The following review of the biology of 40 trawl-caught species of Western Indonesia was written for a number of interrelated purposes:

1) to serve as repository for selected information on commercially (or potentially) important fish resources, extracted from the trawl surveys documented elsewhere in this book;
2) to make available, in a single source document, key parameters on the biology of these important species for stock assessment and related purposes in Indonesia and other countries with similar ichthyofauna;
3) to refute for audiences elsewhere, the often-stated but increasingly untrue statement that "nothing is known on the biology of tropical fishes" and, last but not least;
4) to illustrate how information extracted from FishBase, the computerized encyclopedia of fishes (see Froese et al., this vol.) can be combined with field data to characterize any species of fish.

Materials and Methods

The catch/effort data obtained during the trawl survey o *Jurong, Mutiara 4, Dr. Fridtjof Nansen, Lemuru* and *Bawal Puti 2*, documented in Lohmeyer (this vol.), Bianchi (this vol. Martosubroto (this vol.), Pauly et al. (this vol.), Bianchi et a (this vol.) and Torres et al. (this vol.) were used to identify 4 important teleosts species of Western Indonesia, listed on Tabl 1 in taxonomic order. For each species, the following i presented, so far available:

i) Valid scientific name (including author and date), and common names, in English and Indonesian when available (see Froese et al., this vol.);
ii) A brief description of the distinctive characteristics of the species including meristic counts, adapted wherever possible from the appropriate FAO species catalogues. The graph illustrating each species was either scanned, or redrawn by Mr. Robbie Cada, of the FishBase project, based on various sources. Maximum lengths are given for each species, and may refer to total length (TL), fork length (FL) or standard length (SL); these codes are omitted when the length type could not be determined from the reference used. These

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a) reported maximum length of any specimen of the species in question, from locations outside Indonesia (here coded L_{max1});
b) maximum length in Indonesia, as observed during the surveys reported upon in this volume or related publications (here coded L_{max2});
c) maximum length (and 95% confidence interval) that may be expected in Indonesia, based on the maxima of a series of length-frequency samples and on extreme value theory (Formacion et al. 1991). Such values are here coded L_{max3}, and are presented along with the graph through which they were estimated, themselves outputs of the FiSAT software (Gayanilo et al. 1996);

iii) Geographic distribution: outside Indonesia through a brief text, and within Indonesia through a map generated by the MAPPER software (Coronado and Froese 1994) and showing the occurrences of each species at stations covered by the surveys documented in this volume;
iv) Graphs illustrating the depth distribution of each species in a survey conducted in Western Indonesia;
v) A brief account of the biology of the species. Emphasis herein is given to habitats, food and feeding habits and, so far available, to estimates of the von Bertalanffy (1951) growth function (VBGF) for the species in question, either in Indonesia or elsewhere. The VBGF has, for length, the form

$$L_t = L_\infty (1-\exp(-K(t-t_0))) \quad \textbf{...1)}$$

where L_∞ is the mean length the fish of the population would reach if they were to grow indefinitely (here always in cm), K is the rate at which L_∞ is approached, and t_0 is the theoretical age the fish would have had at length zero if they had always grown according to the VBGF. This parameter, difficult to estimate in the absence of *absolute* age data (i.e., when L_∞ and K are estimated from length-frequency data, as is also the case for Indonesian fishes) is not given here. Few stock assessment models require t_0, in any case.

Box 1. Estimating the parameters of length-weight relationships from length-frequency samples and their weights.
[Boks 1. Estimasi parameter hubungan panjang-berat dari contoh frekuensi-panjang dan berat.]

Length-weight relationships, in fisheries biology, usually take the form

$$W = a \cdot L^b \quad \textbf{...1)}$$

where W is the body weight (live or gutted) of the fish, a is a multiplicative factor, L a linear measure (e.g., total or fork length) of the fish body, and b is an exponent, usually close to 3 but which may range from 2.5 to 3.5 and exceptionally from 2 to 4.

Estimating the parameters of such relationships is usually straightforward, and is usually done by plotting the logarithms of the available individual weights against the logarithms of the corresponding lengths, i.e.,

$$\log(W) = \log(a) + b\log(L) \quad \textbf{...2)}$$

and using a Type I (or predictive) linear regression to estimate log(a) and b. Variants of this approach exist, but this need not concern us here, as we deal below with cases where the available data do not consist of L-W data pairs.

During the demersal trawl surveys described in this volume, there was often not enough time for fully analyzing the catch of one station before the catch of the next station was hauled in; such cases resulted in aggregated data, i.e., samples of fish that had been *measured* individually, leading to length-frequency samples (L/F), but not *weighted* individually. Thus, only the bulk weights of the L/F are available (accurate shipborn weighting of small fishes was usually not possible anyway).

We present here a new method to estimate a and b in length-weight relationships using such data; this requires the computation of "pseudoweights", i.e., of sample weights obtained using estimates of the parameters a and b of a length-weight relationship.

Estimating the pseudoweight of samples requires an accurate estimator of the mean weight ($\bar{w}_i$) of the fish within a given length class (i), which is not equal to the weight corresponding to the midpoint of that length class, or midlength. For this, we use

$$\bar{w}_i = (1 / L_{i+1} - L_i) \cdot (a / b+1) \cdot (L_{i+1}^{b+1} - L_i^{b+1}) \quad \textbf{...3)}$$

where a and b are as defined in Equation (1).

The pseudoweight (W'j) of a given sample (j) is then estimated from

$$W'_j = \sum_{i=1}^{n_j} \left(\bar{w}_i \cdot f_{i,j}\right) \quad \textbf{...4)}$$

where:

$\bar{w}_i$ is the mean weight of class i (Equation 3);
fi,j is the frequency of class i in sample j; and
nj is the number of classes in sample j.

When a number ($\geq$ 3) of length-frequency samples and their bulk weights are available, a and b can be estimated iteratively, using arbitrary seed values of a and b (e.g., a = 0.01 and b = 3), and using a nonlinear least squares procedure (here: Marquardt's compromise algorithm) which minimizes the sum of the squared differences (SSE) between the sample weights (Wj) and the pseudoweights (W'j), both previously log-transformed to stabilize the variance, or

$$SSE = \sum \left[\log(W_j) - \log(W'_j)\right]^2 \quad \textbf{...5)}$$

The results of the final iteration can be shown by plotting the sample pseudoweights against the observed sample weights; this leads to graphs such as shown in this contribution, which can be used to identify outliers.

These steps are all quickly performed by a new software, ABee, available from ICLARM, and which includes a version of Marquardt's algorithm that provides standard errors for all parameter estimates.

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A length-weight relationship of the form

$$W = a \cdot L^b \qquad \text{...2)}$$

is also given for each species. The parameters a and b of equation (2) are usually estimated from the intercept and slope, respectively of a linear regression i.e.,

$$\log(W) = \log(a) + b\log(L) \qquad \text{...3)}$$

A new method was developed, while compiling this review, to estimate the parameters a and b of such relationship from length-frequency samples and their bulk weights (Box 1). This method was applied wherever suitable data were available.

vi) Finally, for each species, we give the (FishBase) numbers of the references documenting the sources of data in (i) to (v) (see Appendix I for full references).

Results

The 40 species considered in this review are listed in Table 1, in the sequence also used for presentation of results on a per-species basis.

Table 1. Classification (from Eschmeyer 1990; see also Froese et al., this vol.) of 40 trawl-caught teleosts of Western Indonesia.
[Tabel 1. Klasifikasi (menurut Eschmeyer 1990; lihat juga Froese et al., dalam buku ini) dari 40 spesies ikan demersal penting di Indonesia bagian barat.]

Clupeiformes Clupeidae *1 Amblygaster sirm* *2 Dussumieria acuta* *3 Pellona ditchela* *4 Sardinella gibbosa* *5 Sardinella lemuru* Siluriformes Ariidae *6 Netuma thalassina* Aulopiformes Synodontidae *7 Saurida micropectoralis* *8 Saurida undosquamis* Perciformes Carangidae *9 Carangoides malabaricus* *10 Caranx ignobilis* *11 Caranx tille* *12 Decapterus macrosoma* *13 Decapterus russelli*	*14 Parastromateus niger* *15 Selar crumenophthalmus* Gerreidae *16 Pentaprion longimanus* Haemulidae *17 Diagramma pictum* *18 Pomadasys argenteus* *19 Pomadasys maculatus* Lactariidae *20 Lactarius lactarius* Leiognathidae *21 Leiognathus splendens* *22 Leiognathus bindus* *23 Leiognathus equulus* *24 Leiognathus leuciscus* *25 Gazza minuta* Lethrinidae *26 Gymnocranius grandoculis* Lutjanidae *27 Aprion virescens* *28 Pristipomoides typus*	Mullidae *29 Upeneus moluccensis* *30 Upeneus sulphureus* Nemipteridae *31 Nemipterus thosaporni* Priacanthidae *32 Priacanthus macracanthus* Scombridae *33 Rastrelliger kanagurta* *34 Scomberomorus commerson* *35 Scomberomorus guttatus* Sphyraenidae *36 Sphyraena obtusata* Stromateidae *37 Pampus argenteus* Terapontidae *38 Terapon jarbua* Trichiuridae *39 Trichiurus lepturus* Tetraodontiformes Balistidae *40 Abalistes stellatus*

Amblygaster sirm (Walbaum, 1792)

Spotted sardinella (English); sardin (Indonesian).

Scutes not prominent. Distinguished from *A. leiogaster* and *A. clupeoides* by the presence of a series of 10 to 20 gold (in life) or black (on preservation) spots down the flank (but sometimes missing) and more lower gillrakers, and from *Sardinella* species by its fewer pelvic finrays and lower gillrakers. Dorsal spines: 0-0; soft rays: 13-21; anal spines: 0-0; soft rays: 12-23. L_{max1} = 26 cm (Sudan, Red Sea); L_{max2} = 20 cm; L_{max3} = 22.7 cm TL (Fig. 1A). See Fig. 1B and Table 2 for length-weight relationship.

Indo-West Pacific: coasts of Africa, including Red Sea and Madagascar to Southeast Asia (Fig. 2). Extending northeastward to Taiwan, and Okinawa (Japan), and southeastward to New Guinea, the northern coasts of Australia and Fiji.

A schooling species occurring in coastal waters. Depth range: 10-75 m (Fig. 3). Feeds mainly on small crustaceans and their larvae, larval bivalves and gastropods, as well as phytoplankton (e.g., *Peridinium, Ceratium*). Table 3 presents three sets of growth parameters from Indonesia.

References: 171, 188, 312, 762, 823, 1263, 1314, 1439, 1442, 1443, 1444, 1447, 1488, 1602, 1911, 2178, 2857, 3785, 4615, 5213, 5525, 5542, 5730, 5736, 5756, 5763, 6313

Table 2. Length-weight (g/[TL;cm]) relationship of spotted sardinella, *Amblygaster sirm*, in Indonesia.
[Tabel 2. Hubungan panjang-berat (g/[TL;cm]) dari ikan sardin, Amblygaster sirm, *di Indonesia.]*

Parameter	Estimate
a	0.1177
s.e.(a)	0.1265
b	2.0748
s.e.(b)	0.3688
r^2	0.9933

Table 3. Growth parameters of spotted sardinella, *Amblygaster sirm.*
[Tabel 3. Parameter pertumbuhan ikan sardin, Amblygaster sirm.*]*

Parameter	A	B	C
L_∞ (TL, cm)	25.2	25.8	24.3
K ($year^{-1}$)	1.175	1.150	0.586

A. "Java Sea" (Ref. 1447)
B. Off Pekalongan, North/Central Java (Ref. 1314)
C. Thousand Islands, Java (Ref. 823)

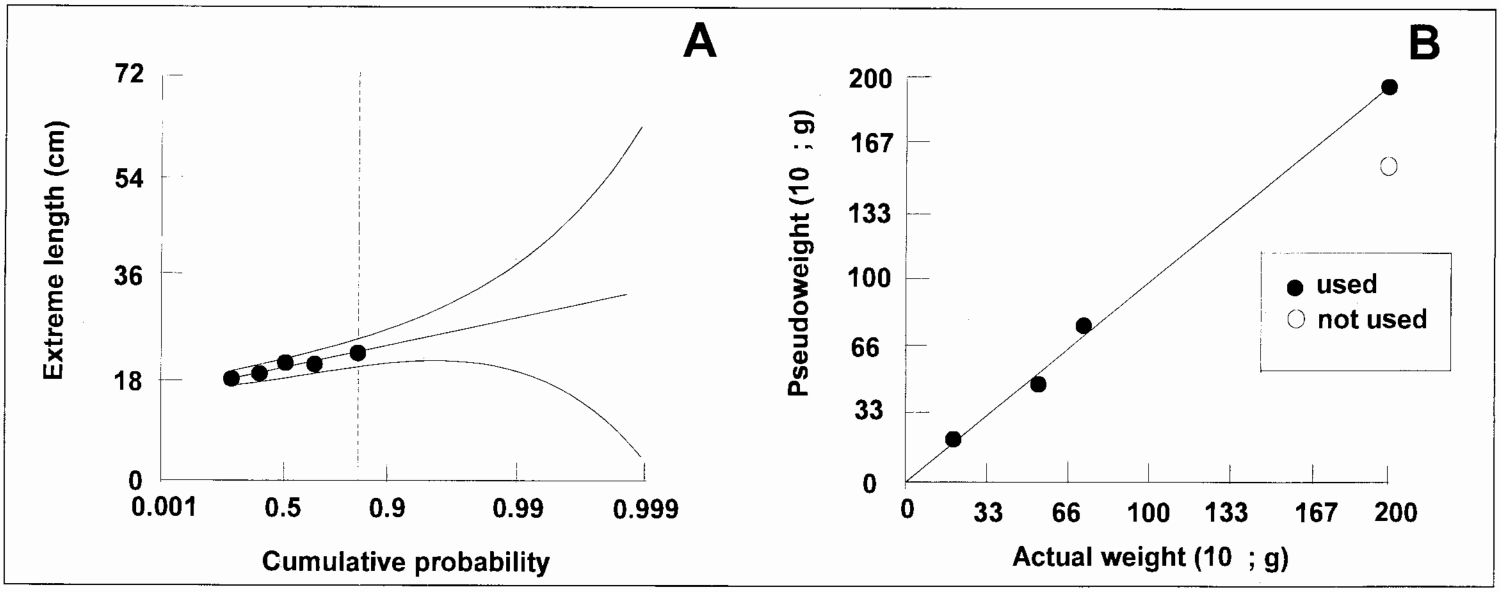

Fig. 1. (A) Extreme value plot for spotted sardinella, *Amblygaster sirm*, in Indonesia based on data from *R/V Dr. Fridtjof Nansen*, showing maxima of 5 length-frequency samples, and estimate of L_{max3} = 22.7 ± 2.2 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 4 length-frequency samples of *Amblygaster sirm* from northern Borneo based on data from *R/V Dr. Fridtjof Nansen* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 2). Open dot represents an outlier not used for analysis.
[Gambar 1. (A) Gambaran nilai ekstrim untuk ikan sardin, Amblygaster sirm, *di Indonesia berdasarkan data dari kapal penelitian* Dr. Fridtjof Nansen, *yang menunjukkan nilai maksimum dari 5 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 22.7 ± 2.2. cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 4 contoh frekuensi panjang ikan sardin,* Amblygaster sirm, *dari Kalimantan berdasarkan data* Dr. Fridtjof Nansen *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 2) . Bulatan kosong mewakili suatu pengamatan yang tidak dipakai dalam analisis.]*

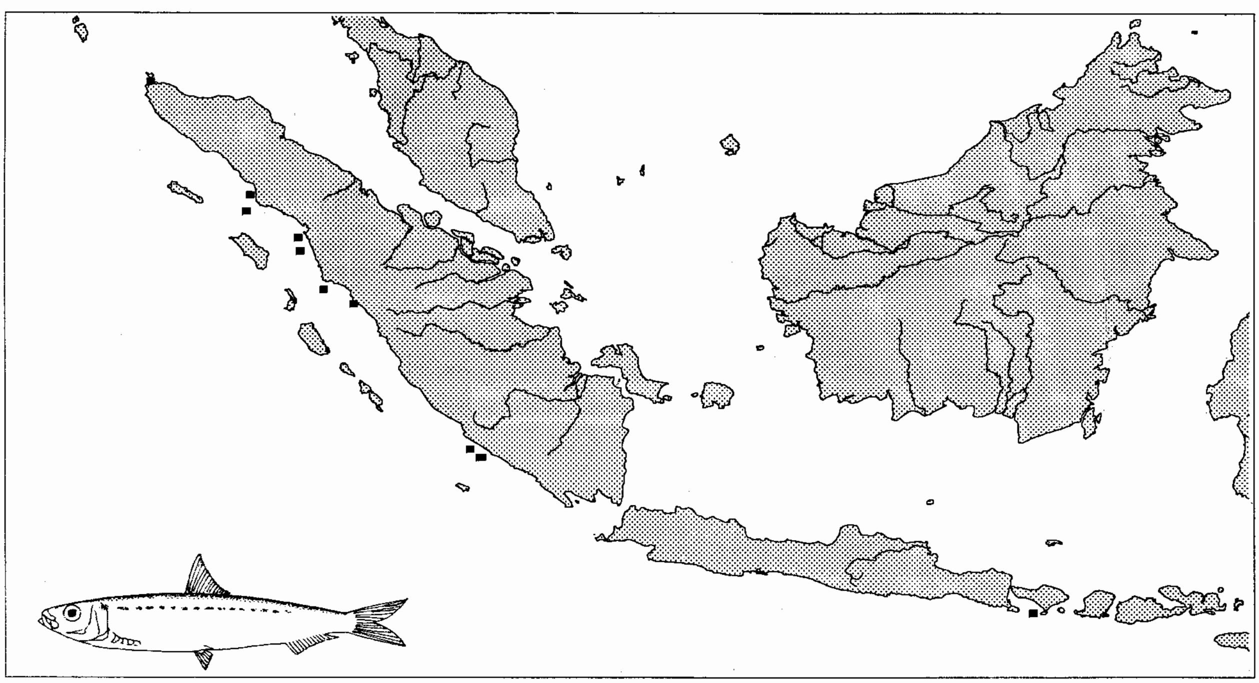

Fig. 2. Distribution of spotted sardinella, *Amblygaster sirm*, in Western Indonesia based on records of the surveys of *R/V Dr. Fridtjof Nansen.*
[Gambar 2. Penyebaran ikan sardin, Amblygaster sirm, *di Indonesia bagian barat berdasarkan laporan survei kapal penelitian* Dr. Fridtjof Nansen.*]*

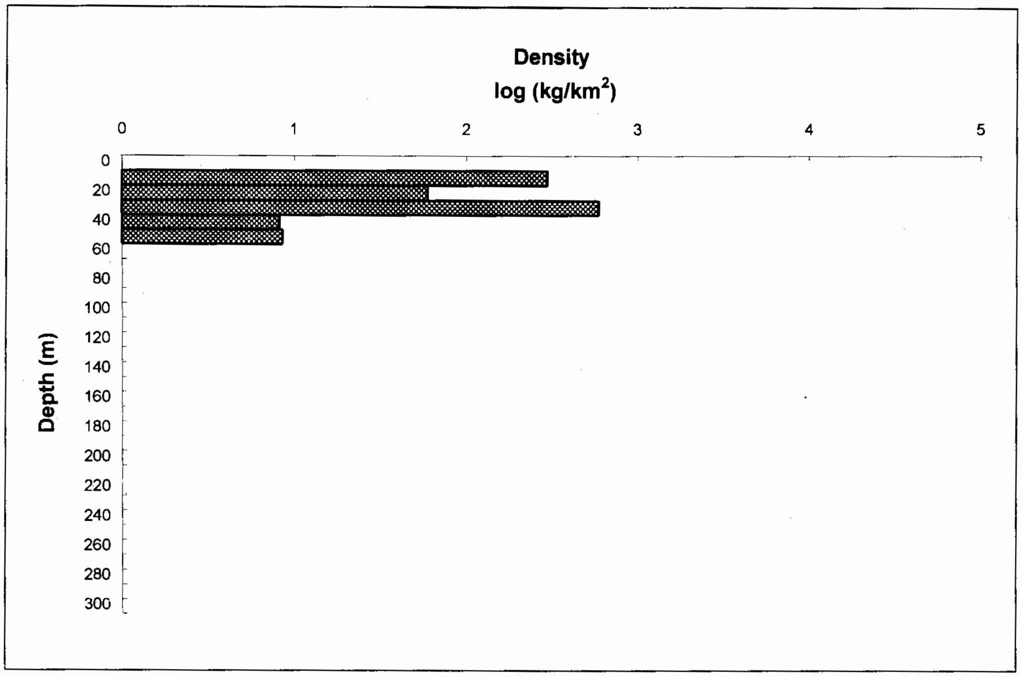

Fig. 3. Depth distribution of spotted sardinella, *Amblygaster sirm*, in Western Indonesia based on surveys of *R/V Dr. Fridtjof Nansen*.
[Gambar 3. Penyebaran kedalaman ikan sardin, Amblygaster sirm, *di Indonesia bagian barat berdasarkan survei kapal penelitian* Dr. Fridtjof Nansen.*]*

Dussumieria acuta (Valenciennes, 1847)

Rainbow sardine (English); Djapuh (Indonesian); Ajapu, Djapuh (West Java, Jakarta); Tjapo (Madura); Tembang djawa (South Sulawesi, Makassar); Tembang rakapeng (South Sulawesi, Bugis); Bete kalo (South Sulawesi, Badjo).

Brachiostegal rays fewer (12 to 15) and posterior part of scales marked with numerous tiny radiating striae. Color is iridescent blue with a shiny gold/brass line below (quickly fading after death). W-shaped pelvic scute; isthmus tapering evenly forward; more anal finrays. Dorsal spines: 0-0; soft rays: -; anal spines: 0-0; soft rays: 14-18. L_{max1} = 20 cm SL; L_{max2} = n.a.; L_{max3} = 20.9 cm TL (Fig. 4A). See Fig. 4B and Table 4 for length-weight relationship.

Warmer waters of the Indo-Pacific, from the Persian Gulf (and perhaps south to Somalia), along the coasts of Pakistan, India and Malaysia to Indonesia (Fig. 5) and the Philippines. Earlier records included *D. elopsoides*.

Mainly an inshore species. Depth range: 10-120 m (Fig. 6). Earlier studies on the habitat and biology may have equally referred to *D. elopsoides* which this species closely resembles.

References: 171, 188, 280, 1449, 2178, 2857, 2860, 4789, 5193, 5381, 5525, 5541, 5579, 5730, 5736, 5756, 6313, 6328, 6365

Table 4. Length-weight (g/[TL;cm]) relationship of rainbow sardine, *Dussumieria acuta*, in Indonesia.
[Tabel 4. Hubungan panjang-berat [g/(TL; cm)] ikan japuh, Dussumieria acuta*, di Indonesia.]*

Parameter	Estimate
a	0.0056
s.e.(a)	0.00402
b	3.1462
s.e.(b)	0.25642
r^2	0.9692

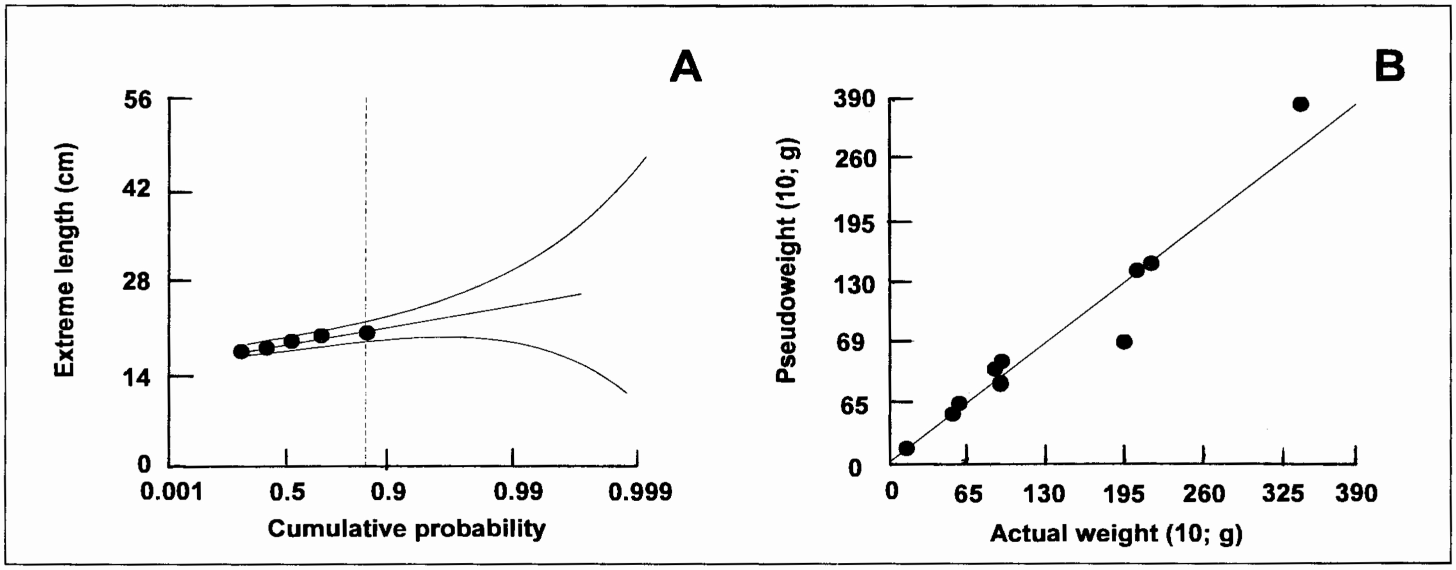

Fig. 4. (A) Extreme value plot for rainbow sardine, *Dussumieria acuta,* in Indonesia based on data from *R/Vs Mutiara 4, Jurong* and *Dr. Fridtjof Nansen*, showing maxima of 5 length-frequency samples, and estimate of L_{max3} = 20.9 ± 1.5 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 10 length-frequency samples of rainbow sardine, *Dussumieria acuta,* from Western Indonesia based on data from *R/Vs Dr. Fridtjof Nansen, Mutiara 4* and *Jurong* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 4).

[Gambar 4. (A) Gambaran nilai ekstrim dari ikan japuh, Dussumieria acuta, *di Indonesia berdasarkan data kapal penelitian* Mutiara 4, Jurong *dan* Dr. Fridtjof Nansen, *yang menunjukkan nilai maksimum dari 5 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 20.9 ± 1. 5 cm TL. (B) Berat prediksi terhadap berat-berat observasi (dalam g berat basah) dari 10 contoh frekuensi-panjang ikan japuh,* Dussumieria acuta, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Dr. Fridtjof Nansen, Mutiara 4 *dan* Jurong *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 4).]*

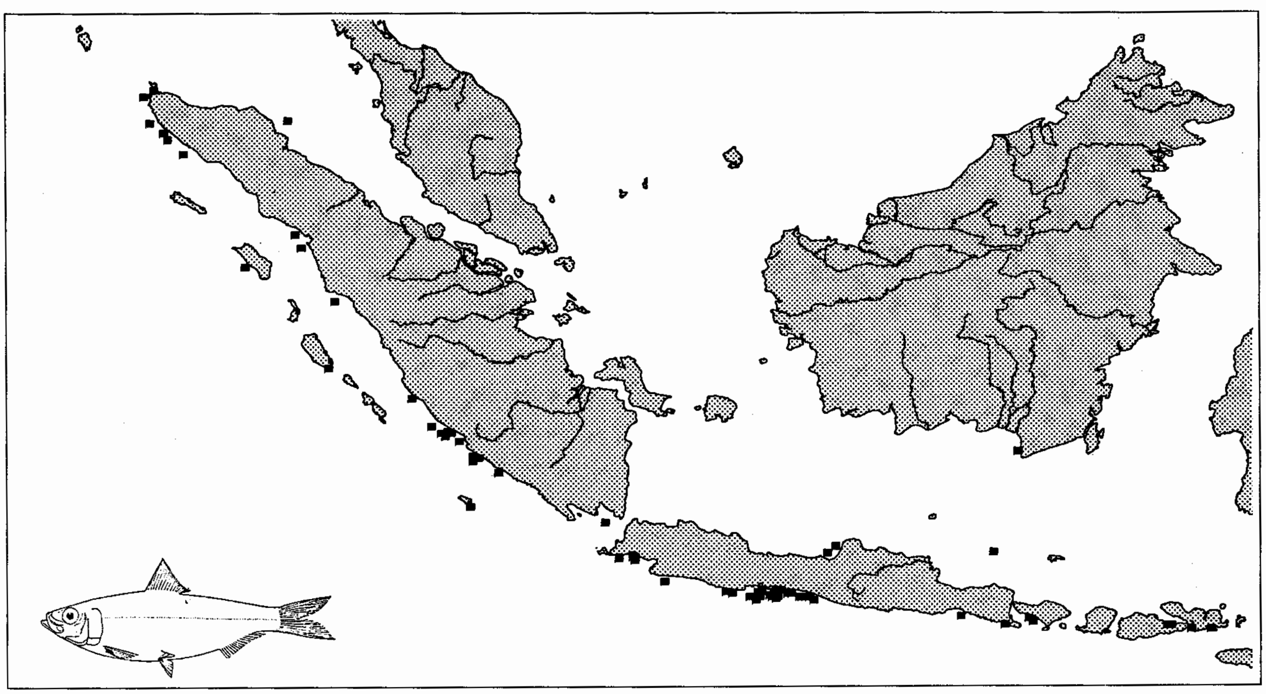

Fig. 5. Distribution of rainbow sardine, *Dussumieria acuta,* in Western Indonesia based on records of the surveys of *R/Vs Dr. Fridtjof Nansen, Mutiara 4, Jurong* and *Bawal Putih 2.*

[Gambar 5. Penyebaran ikan japuh, Dussumieria acuta, *di Indonesia bagian barat berdasarkan laporan survei kapal-kapal penelitian* Dr. Fridtjof Nansen, Mutiara 4, Jurong *dan* Bawal Putih 2.*]*

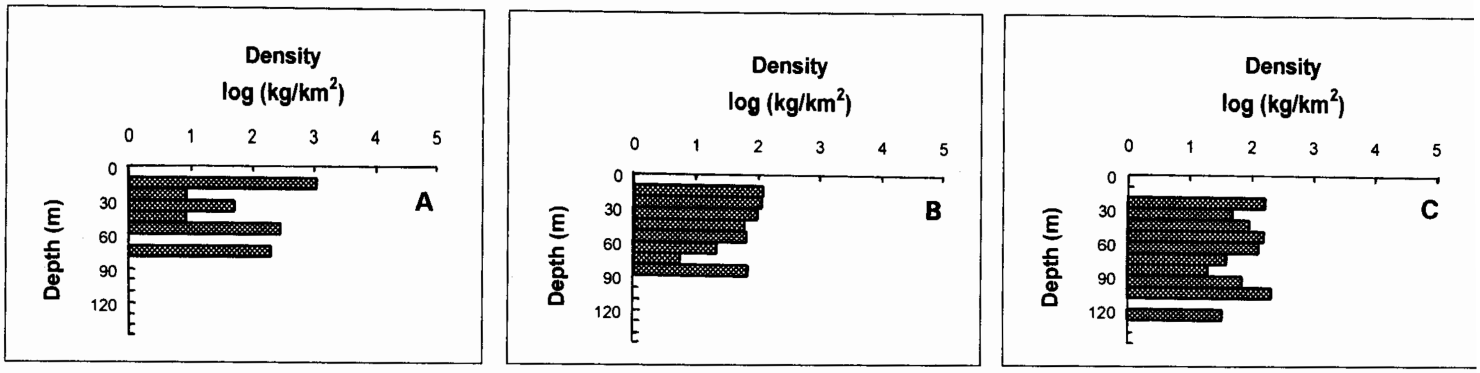

Fig. 6. Depth distribution of rainbow sardine, *Dussumieria acuta*, in Western Indonesia based on records of the surveys of *R/Vs* (A) *Dr. Fridtjof Nansen*, (B) *Mutiara 4* and (C) *Jurong*.
[Gambar 6. Penyebaran kedalaman ikan japuh, Dussumieria acuta, *di Indonesia bagian barat berdasarkan laporan survei kapal-kapal penelitian: (A)* Dr. Fridtjof Nansen, *(B)* Mutiara 4, *dan (C)* Jurong.*]*

Pellona ditchela (Valenciennes, 1847)

Indian pellona (English); Dero (Indonesian); Dero, Longlong mata (Java); Puput (West Java, Jakarta).

Belly with usually 18 or 19 + 8 or 9, total 26 to 28 scutes, strongly keeled. Eye large, lower jaw projecting. Dorsal fin origin near midpoint of body. Scales with upper and lower vertical striae slightly overlapping each other at center of scales. Dorsal spines: 0-0; soft rays: 0-0; anal spines: 0-0; soft rays: 34-42. L_{max1} = 16 cm SL; L_{max2} = n.a.; L_{max3} = 17.7 cm TL (Fig. 7A). See Fig. 7B and Table 5 for length-weight relationship.

Indian Ocean: Madagascar, and from Durban, South Africa to the Gulf of Oman and the coasts of India. From the Andaman Sea to Indonesia (Fig. 8) and the Philippines; southeast to Papua New Guinea and Northern and Western Australia.

Occurs in coastal areas, entering mangrove swamps and penetrating estuaries and freshwater. Depth range: 10-55 m (Fig. 9).

References: 171, 188, 1455, 2857, 3225, 3509, 4749, 4789, 4959, 4967, 5193, 5213, 5284, 5339, 6313, 6365, 6567, 6822

Table 5. Length-weight (g/[TL;cm]) relationship of Indian pellona, *Pellona ditchela*, in Indonesia.
[Tabel 5. Hubungan panjang-berat (g/[(TL; cm]) ikan puput, Pellona ditchela, *di Indonesia.]*

Parameter	Estimate
a	0.0018
s.e.(a)	0.00357
b	3.6209
s.e.(b)	0.62929
r^2	0.9988

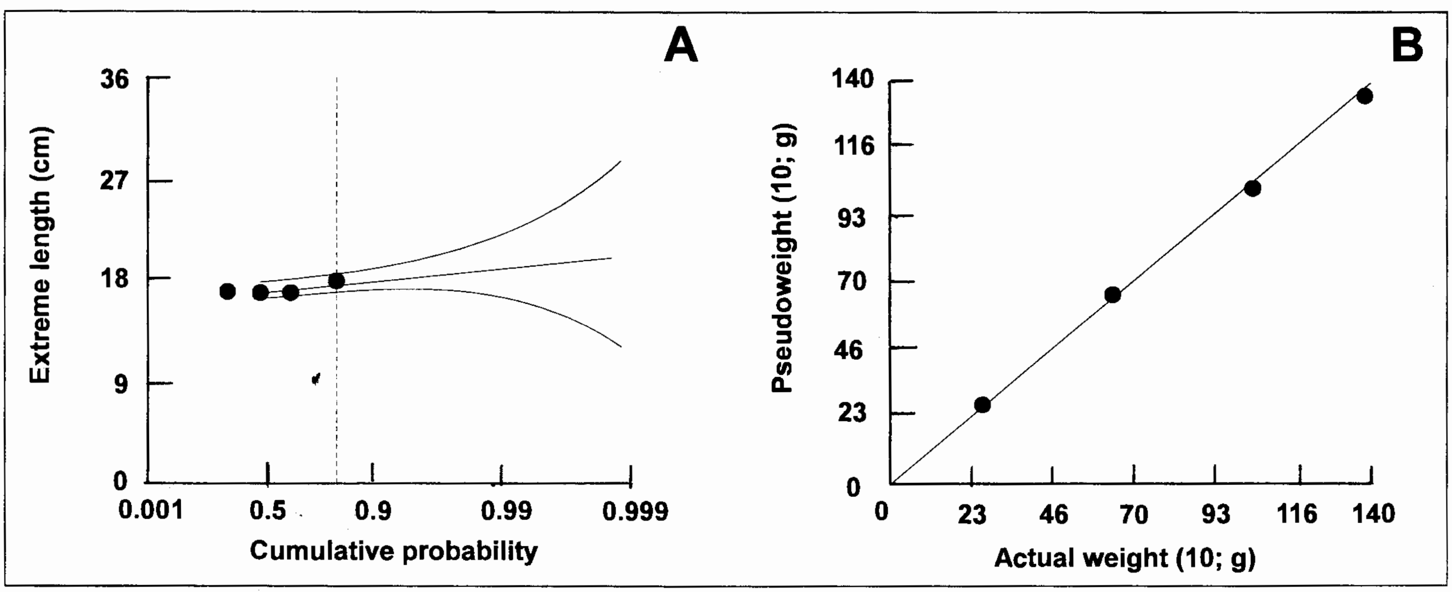

Fig. 7. (A) Extreme value plot for Indian pellona, *Pellona ditchela*, in Indonesia based on data from *R/V Dr. Fridtjof Nansen* showing maxima of 4 length-frequency samples, and estimate of L_{max3} = 17.7 ± 0.6 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 4 length-frequency samples of Indian pellona, *Pellona ditchela*, from northern Borneo based on data from *R/V Dr. Fridtjof Nansen* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 5).
[Gambar 7. (A) Gambaran nilai ekstrim dari ikan puput, Pellona ditchela, *di Indonesia berdasarkan data dari kapal penelitian* Dr. Fridtjof Nansen *yang menunjukkan 4 contoh frekuensi panjang dan angka perkiraan L_{max3} = 17.7 ± 0.6 cm TL . (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 4 contoh frekuensi panjang ikan puput,* Pellona ditchela, *dari Kalimantan Utara berdasarkan data dari kapal penelitian* Dr. Fridtjof Nansen

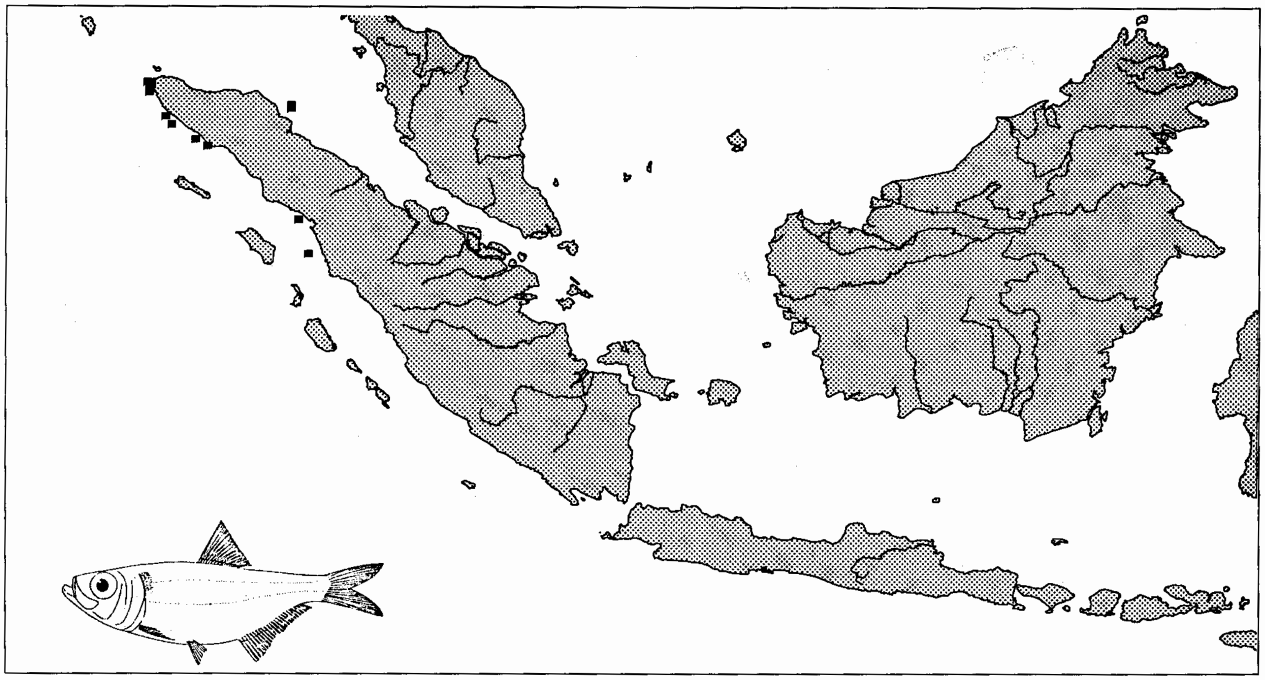

Fig. 8. Distribution of Indian pellona, *Pellona ditchela*, in Western Indonesia based on records of the surveys of *R/V Dr. Fridtjof Nansen.*

[Gambar 8. Penyebaran ikan puput, Pellona ditchela, *di perairan Indonesia bagian barat berdasarkan laporan survei dari kapal penelitian* Dr. Fridtjof Nansen.*]*

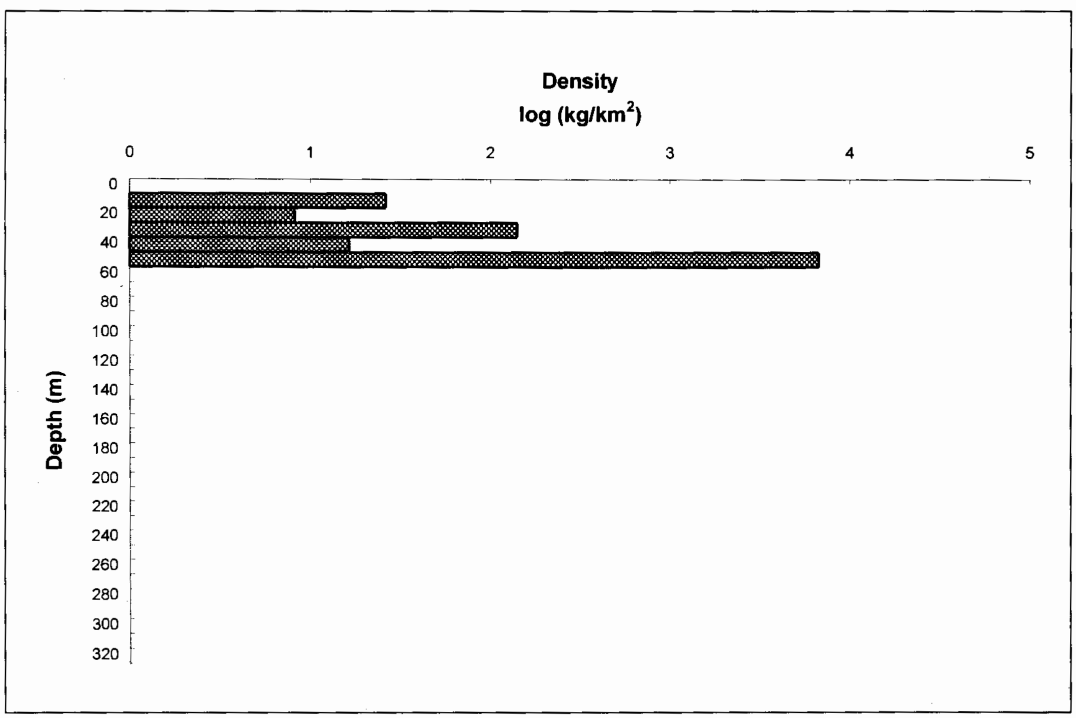

Fig. 9. Depth distribution of Indian pellona, *Pellona ditchela*, in Western Indonesia based on surveys of *R/V Dr. Fridtjof Nansen.*

[Gambar 9. Penyebaran kedalaman ikan puput, Pellona ditchela, *di Indonesia bagian barat berdasarkan survei dengan kapal penelitian* Dr. Fridtjof Nansen.*]*

Sardinella gibbosa (Bleeker, 1849)

Goldstriped sardinella (English); Tembang (Indonesian); Djuwi djuwi, Mursiah, Tjiro (Java); Tamban sisik, Tembang, Tembang djuwi (West Java, Jakarta); Maos, Tandjan (West Java, Bandung); Sintring (Madura); Djurung (East Sumatra); Tamban (South Borneo); Tembang lakara (South Sulawesi, Bugis); Totata (South Sulawesi, Badjo); Mengida (Bali).

Total number of scutes: 32 to 34. A golden mid-lateral line down flank; dorsal and caudal fin margins dusky; a dark spot at dorsal fin origin. Lower gillrakers: 45 to 59 (at 6 to 17 cm SL, not increasing with size of fish after 6 cm SL). Dorsal spines: 0-0; soft rays: 13-21; anal spines: 0-0 soft rays: 12-23. L_{max1} = 17 cm SL. L_{max2} = n.a.; L_{max3} = 20.2 cm TL (Fig. 10A). See Fig. 10B and Table 6 for length-weight relationship.

Indo-West Pacific: from the East African coasts (but not the Red Sea) and Madagascar eastward to the Persian Gulf and Indonesia (Fig. 11), north to Taiwan and Korea; south to Northern Australia. In India, often confused with *S. fimbriata*.

Forms schools in coastal waters. Depth range: 10-70 m (Fig. 12). Feeds on phytoplankton and zooplankton (crustacean and molluscan larvae). Table 7 presents a set of growth parameters from Indonesia.

References: 171, 188, 280, 811, 1314, 1443, 1444, 1488, 1504, 1529, 1751, 2178, 2857, 2948, 3560, 3605, 4330, 4331, 5213, 5284, 5730, 5736, 5756, 6313, 6365

Table 6. Length-weight (g/[TL;cm]) relationship of goldstriped sardinella, *Sardinella gibbosa*, in Indonesia.
[Tabel 6. Hubungan panjang-berat (g/[(TL; cm]) dari ikan tembang, Sardinella gibbosa, *di Indonesia.]*

Parameter	Estimate
a	0.0158
s.e.(a)	0.0136
b	2.7837
s.e.(b)	0.3073
r^2	0.9778

Table 7. Growth parameters of goldstriped sardinella, *Sardinella gibbosa*.
[Tabel 7. Parameter pertumbuhan ikan tembang, Sardinella gibbosa.*]*

Parameter	A
L_∞ (TL, cm)	19.5
K (year^{-1})	1.20

A. Riau waters (Ref. 1314)

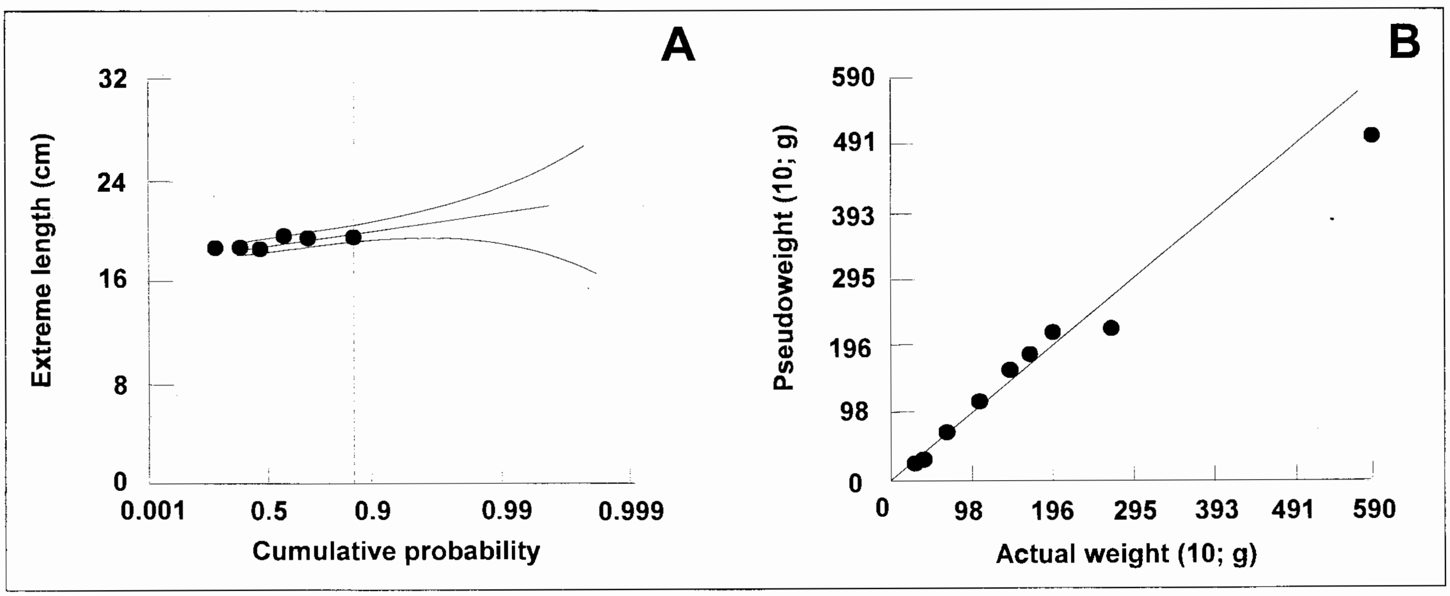

Fig. 10. (A) Extreme value plot for goldstriped sardinella, *Sardinella gibbosa*, in Indonesia based on data from *R/V*s *Mutiara 4, Jurong* and *Dr. Fridtjof Nansen*, showing maxima of 6 length-frequency samples, and estimate of L_{max3} = 20.2 ± 0.6 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 9 length-frequency samples of goldstriped sardinella, *Sardinella gibbosa,* from Western Indonesia based on data from *R/V*s *Mutiara 4, Jurong* and *Dr. Fridtjof Nansen* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 6).
[Gambar 10. (A) Gambaran nilai ekstrim dari ikan tembang, Sardinella gibbosa, *di Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Jurong *dan* Dr. Fridtjof Nansen, *yang menunjukkan nilai maksimum 6 contoh frekuensi panjang dan nilai perkiraan maksimum L_{max3} = 20.2 ± 0.6 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 9 contoh frekuensi panjang ikan tembang,* Sardinella gibbosa, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Jurong *dan* Dr. Fridtjof Nansen *sebagai output perangkat lunak ABee (lihat Boks 1) dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 6).*

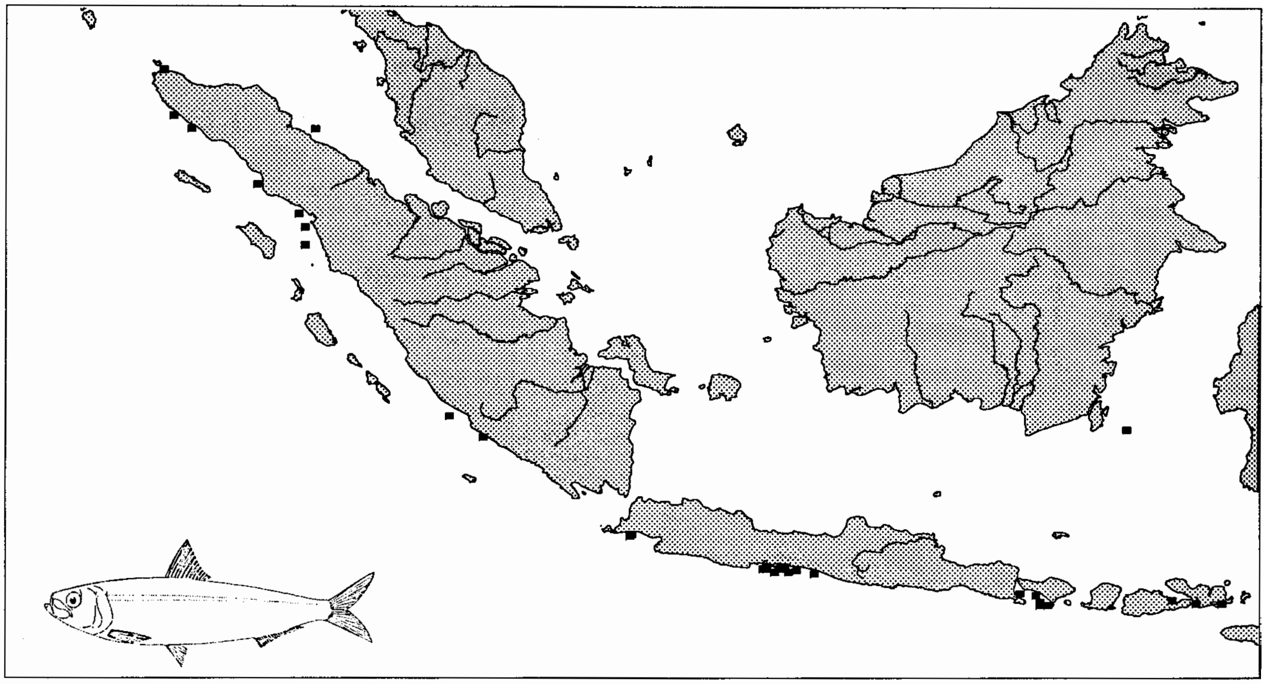

Fig. 11. Distribution of goldstriped sardinella, *Sardinella gibbosa*, in Western Indonesia based on records of the surveys of *R/Vs Mutiara 4*, Bawal *Putih 2, Jurong* and *Dr. Fridtjof Nansen*.
[Gambar 11. Penyebaran ikan tembang, Sardinella gibbosa*, di Indonesia bagian barat berdasarkan laporan survei dari kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong *dan* Dr. Fridtjof Nansen.*]*

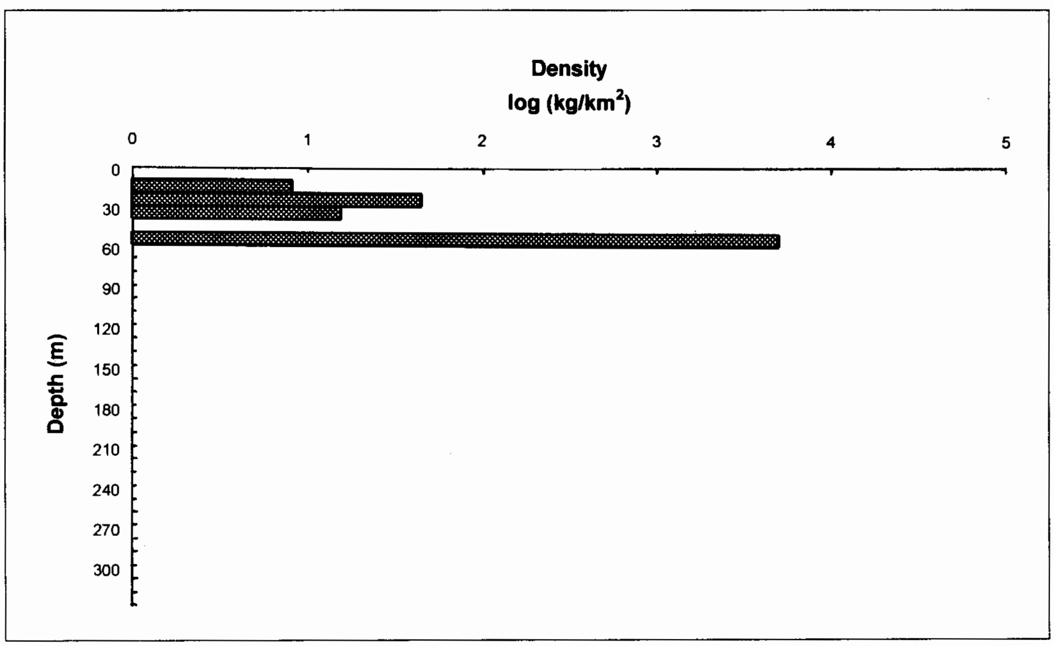

Fig. 12. Depth distribution of goldstriped sardinella, *Sardinella gibbosa*, in Western Indonesia based on surveys of *R/V Dr. Fridtjof Nansen*.
[Gambar 12. Penyebaran kedalaman ikan tembang, Sardinella gibbosa*, di Indonesia bagian barat berdasarkan survei kapal penelitian* Dr. Fridtjof Nansen.*]*

Sardinella lemuru (Bleeker, 1853)

Bali sardinella (English); Tembang montjong (Indonesian); Lemuru (Java); Lemuru, Tembang mata kutjing, Tembang montjong (West Java, Jakarta); Soroi (Madura); Temban montjo (South Sulawesi, Makassar); Bete lalaki (South Sulawesi, Bugis).

A faint golden spot behind gill opening, followed by a faint golden mid-lateral line; a distinct black spot at hind border of gill cover. Body elongate, subcylindrical. Distinguished from all other clupeids in the eastern Indian Ocean and western Pacific by its pelvic finray count of 8; from *S. longiceps* by its shorter head length and fewer lower gillrakers. Dorsal spines: 0-0; soft rays: 13-21; anal spines: 0-0; soft rays: 12-23. L_{max1} = 23 cm SL. L_{max2} = 21 cm TL; L_{max3} = 19.9 cm TL (Fig. 13A). See Fig. 13B and Table 8 for length-weight relationship.

Eastern Indian Ocean: Phuket, Thailand and southern coasts of East Java and Bali (Fig. 14); also in Western Australia, Western Pacific: Java Sea north to the Philippines, Hong Kong, Taiwan Island to southern Japan.

Forms large schools in coastal waters. Depth range: 15-100 m (Fig. 15). Feeds on phytoplankton and zooplankton (chiefly copepods). Ghofar and Mathews (Box 2) discuss the fluctuations of the Bali Straits lemuru fishery from 1976 to 1993. Table 9 presents six sets of growth parameters from Indonesia.

References: 171, 188, 280, 818 819, 1263, 1314, 1392, 1449, 1511, 1830, 2178, 2858, 3268, 3557, 3605, 3784, 5381.

Table 8. Length-weight (g/[TL;cm]) relationship of Bali sardinella, *Sardinella lemuru*, in Indonesia.
[Tabel 8. Hubungan panjang-berat (g/[TL;cm]) dari ikan lemuru, Sardinella lemuru, *di Indonesia.]*

Parameter	A	B
a	0.0012	0.0299
s.e.(a)	0.0012	n.a.
b	3.7515	2.671
s.e.(b)	0.3087	n.a.
r^2	0.9641	n.a.

A. This study
B. Bali Strait (Ref. 3268), L in SL.

Table 9. Growth parameters of Bali sardinella, *Sardinella lemuru*.
[Tabel 9. Parameter pertumbuhan dari ikan lemuru, Sardinella lemuru.*]*

Parameter	A	B	C	D	E	F
L_∞ (TL, cm)	21.6	21.1	22.3	22.5	23.2	23.8
K ($year^{-1}$)	0.95	0.8	0.85	1.0	1.28	0.505

A. Bali Strait (Ref. 3268), L originally in SL.
B. Bali Strait, 1981 (Ref. 1314)
C. Bali Strait, 1977 (Ref. 1314)
D. Bali Strait, 1980 (Ref. 1314)
E. Bali Strait, 1979 (Ref. 1314)
F. Muntjar, Bali Strait (Ref. 819)

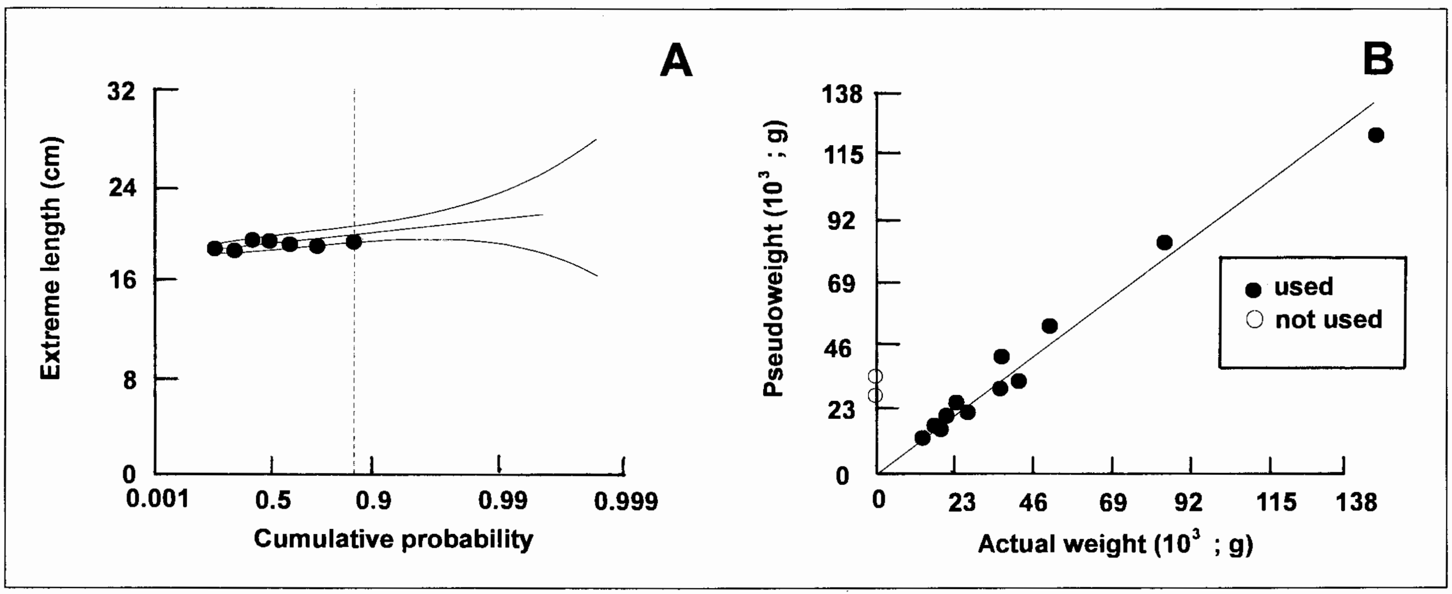

Fig. 13. (A) Extreme value plot for Bali sardinella, *Sardinella lemuru*, in Indonesia based on data from *R/V Jurong*, showing maxima of 7 length-frequency samples, and estimate of L_{max3} = 19.9 ± 0.5 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 12 length-frequency samples of Bali sardinella, *Sardinella lemuru*, from Western Indonesia based on data from *R/V Jurong* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 8). Open dots represent outliers, not used for analysis.

[Gambar 13. (A) Gambaran nilai ekstrim untuk ikan lemuru, Sardinella lemuru, *di Indonesia berdasarkan data dari kapal penelitian* Jurong, *yang menunjukkan nilai maksimum dari 7 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 19.9 ± 0.5 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 12 contoh frekuensi-panjang ikan lemuru,* Sardinella lemuru, *dari Indonesia bagian barat berdasarkan data dari kapal penelitian* Jurong *sebagai output perangkat lunak ABee (lihat Boks 1) dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 8). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

Box 2. The Bali Straits lemuru fishery.
[Boks 2. Perikanan lemuru Selat Bali]

The Bali Straits lemuru (*Sardinella lemuru*) fishery relied until 1975 mainly on small (<5 GT) sail powered boats with a range of up to about 20 nm offshore. In the early fishery four kinds of hand operated gear were used: *payang* (a non-closing surface seine net); *jala buang* (throw net); *serok* (dip net); and *bagan cancap* (lift net), which attract lemuru with lights at night to a bamboo platform: the fish are caught by lifting a large suspended net. Starting aroung the early 1970s, the ca. 9 m boats were motorized, and by the mid-1970s, the older gear was being replaced by (often larger) mechanized purse seiners (*pukat cincin*) which are now the dominant type, with over 85% of the catch; this is taken mainly from October to April, with a strong peak in December and January.

Two data sets on catch and effort are available: 1950-1973 and 1976-1993 (Fig. 1). Both series cover the same stock and area, with catches overwhelmingly (<90%) of lemuru, but have been gathered using different methodologies. Still, increasing mechanization, and natural variations similar to those observed in earlier and later years could account for the jump in landings from ca. 5,000 in 1973 to about 28,000 t·year^{-1} in 1976 recorded at the end of the first, and the beginning of the second, respectively, of the data sets.

Catches show an overall increase, but with marked fluctuations (Fig. 1). Data for 1994 are not yet available but the decline that started in 1993 appears to have continued. Effort was low prior to 1976, but quantitative data are not available. Observed effort changes (Fig. 1) cannot account for the low landings in 1977-1980 and 1985-1987.

To test if lemuru landings may be related to the El Niño/Southern Oscillation (ENSO) events, the catch series were converted into a single series of standardized anomalies (A) by fitting a five-year running mean to the data from 1950 to 1993. We defined $A = (C_o/C_m)-1$, where C_o is the observed catch in a given year, and C_m is the running mean for the same year.

As might be seen from Fig. 1 (insert), high positive anomalies values are clearly related to ENSO events. Therefore, the increased effort directed towards the Bali Straits lemuru stock from 1950 to 1993, which produced an increase in landings for <5,000 t·year^{-1} to >50,000 t·year^{-1} is not the primary cause for the strong catch fluctuations which are probably due to large-scale oceanographic events (see also Sharp, this vol.).

Nevertheless, there is a suggestion that higher effort in the last decades had some effect on the stock: the amplitude of the positive anomalies declines from >1.5 to <0.5 over the time series (Fig. 1, insert), while the amplitude of the negative anomalies remains roughly constant over the whole time series. Perhaps the higher catches in recent years were taken from a stock that has become less resilient, with the fishery removing most of the surplus production. This would prevent the spawning stock from recovering during favorable periods ("E"), making it more vulnerable to fishing during less favorable periods ("N"). This suggests that further effort increases, while not increasing catches, will increase the risk of a collapse. Also, the quick recovery observed from 1986 to 1988 may not recur at higher effort levels. This issue needs further work; to support this, we have contributed our time series of catch and effort data to the database (Diskette 2) described by Torres et al. (this vol.).

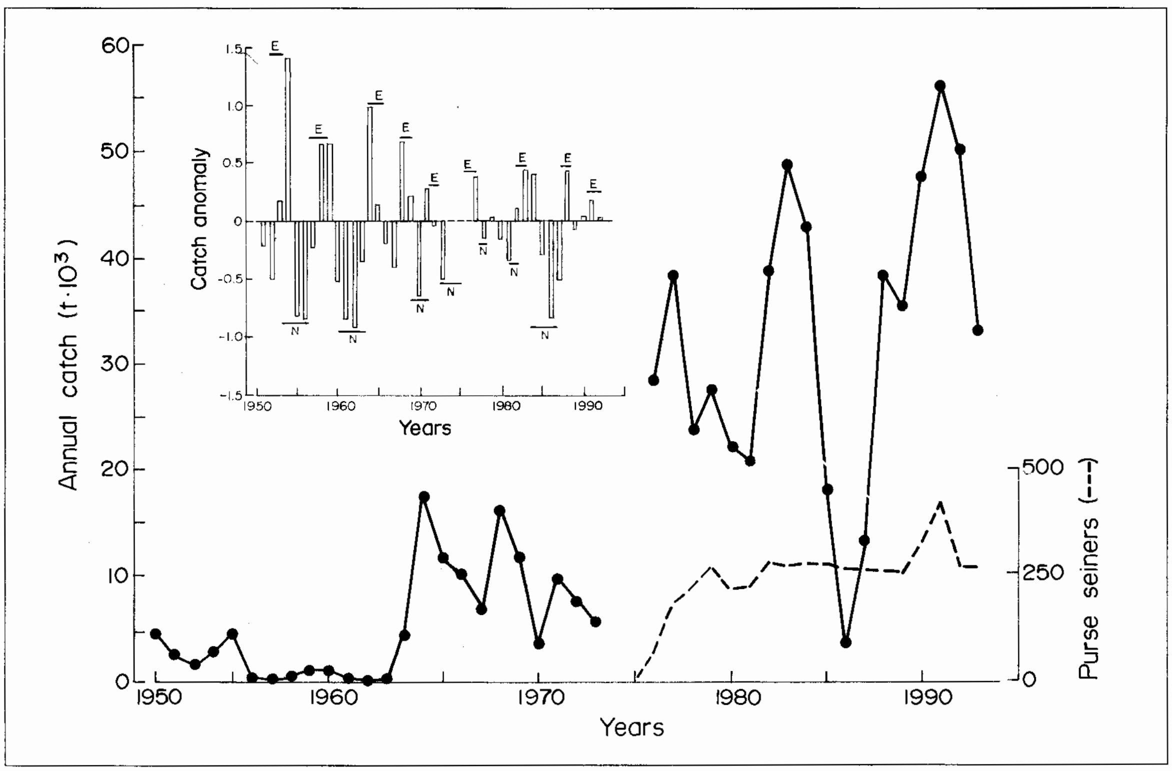

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Fig. 1. Major features of the Bali Straits lemuru fishery.
[Gambar 1. Sifat-sifat utama perikanan lemuru Selat Bali.]
Main panel: catches of 1950 to 1973 (from Ref. 3268); catch and effort for 1976-1993: original data.
Insert: catch anomalies (1950 to 1993) and ENSO events ("E") and their opposite ("N") from Refs. 9577, 9578 and 9580.

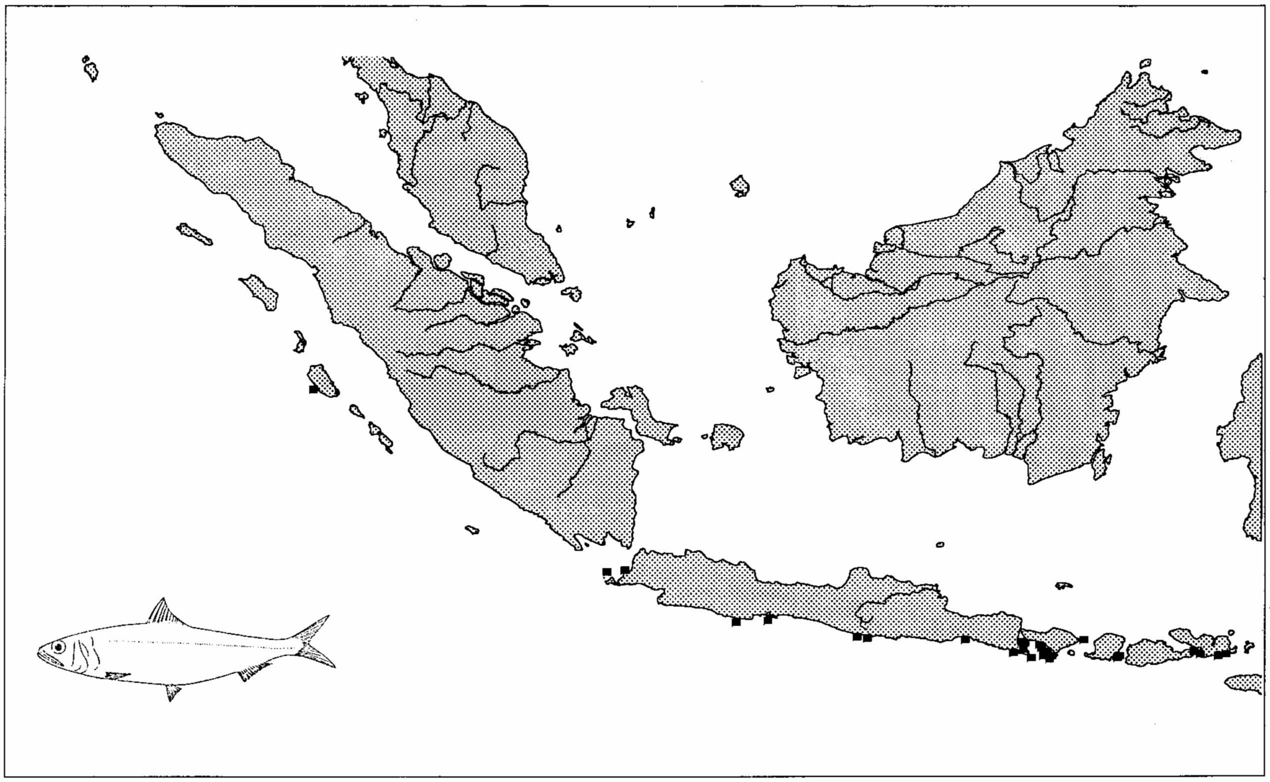

Fig. 14. Distribution of Bali sardinella, *Sardinella lemuru*, in Western Indonesia based on records of the surveys of *R/Vs Jurong* and *Bawal Putih 2*.
[Gambar 14. Penyebaran ikan lemuru, Sardinella lemuru, *di Indonesia bagian barat berdasarkan laporan survei dari kapal-kapal penelitian* Jurong *dan* Bawal Putih 2.*]*

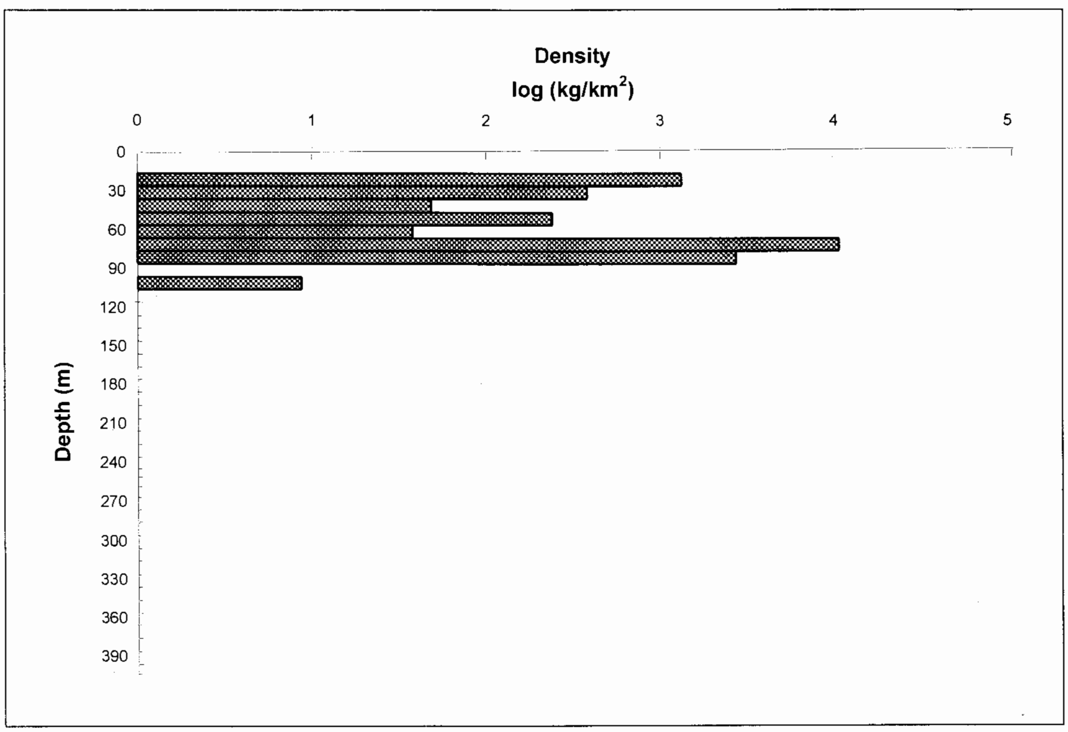

Fig. 15. Depth distribution of Bali sardinella, *Sardinella lemuru,* in Western Indonesia based on surveys of *R/V Jurong*.
[Gambar 15. Penyebaran kedalaman ikan lemuru, Sardinella lemuru, *di Indonesia bagian barat berdasarkan survei kapal penelitian* Jurong.*]*

Netuma thalassina (Rüppell, 1837)

Giant catfish (English); Manjung (Indonesian); Mangmung, Manjong (Java); Manjung kerbo (West Java); Duri padi, Manjung (West Java, Jakarta); Duri utek, Utik (West Java, Jakarta); Gaguk, Putih (South Sumatra); Duri padi, Duri utek (Riouw); Gugup, Gungut (West Borneo); Barukang (South Sulawesi, Makassar); Lampa (South Sulawesi, Badjo).

Head shield weakly striated and granulated, its surface nearly smooth. Three pairs of barbels around mouth. Supraoccipital process about 1.5 times as long as broad. Dorsal spines: 1-1; soft rays: 7-7; anal spines: - ; soft rays: 16-30. L_{max1} = 100 cm TL; L_{max2} = n.a.; L_{max3} = 83 cm TL (Fig. 16A). See Fig. 16B and Table 10 for length-weight relationship.

Indian Ocean: known with certainty only from the Red Sea and northwest Indian Ocean. Malaysia, Indonesia (Fig. 17) and southeast to north Australia.

A marine species often found in estuaries, but rarely enters freshwater; depth range 10-195 m (Fig. 18). Feeds mainly on crabs, prawns, mantis shrimps (*Squilla* spp.) but also on fishes and molluscs. Table 11 presents two sets of growth parameters from Indonesia.

References: 1263, 1314, 2045, 2857, 2872, 3279, 3290, 3627, 3641, 4515, 4557, 4600, 4735, 4789, 4883, 4959, 5213, 5450, 5736, 5756, 6313, 6365, 6567

Table 10. Length-weight (g/[TL;cm]) relationship of giant catfish, *Netuma thalassina,* in Indonesia.
[Tabel 10. Hubungan panjang-berat (g/[TL;cm]) ikan manyung, Netuma thalassina*, di Indonesia.]*

Parameter	Estimate
a	0.0097
s.e.(a)	0.0032
b	3.0404
s.e.(b)	0.0886
r^2	0.9787

Table 11. Growth parameters of giant catfish, *Netuma thalassina.*
[Tabel 11. Parameter pertumbuhan ikan manyung, Netuma thalassina.*]*

Parameter	A	B
L_∞ (TL, cm)	52.7	60.0
K (year^{-1})	0.27	0.65

A. Sampit Bay, Central Kalimantan (Ref. 4557)
B. Java Sea (South Kalimantan) (Ref. 1314)

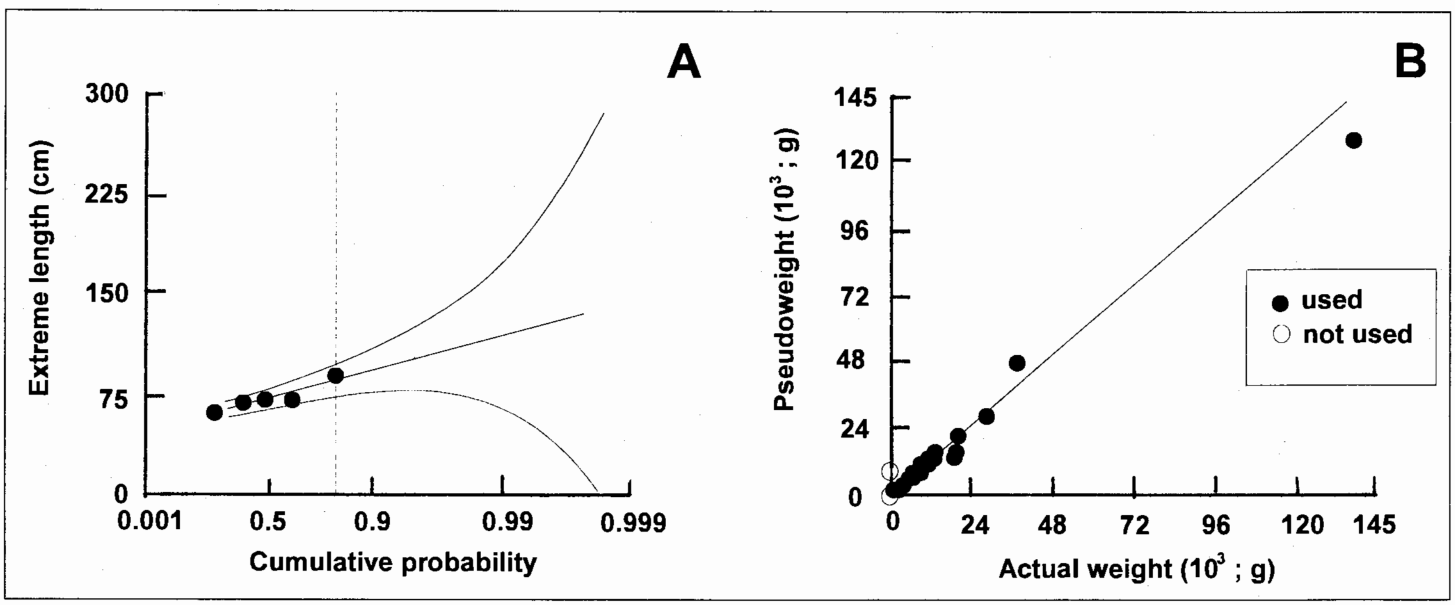

Fig. 16. (A) Extreme value plot for giant catfish, *Netuma thalassina*, in Indonesia based on data from *R/Vs Mutiara 4* and *Jurong*, showing maxima of 5 length-frequency samples, and estimate of L_{max3} = 83.0 ± 11.0 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 26 length-frequency samples of giant catfish, *Netuma thalassina*, from Western Indonesia based on data from *R/Vs Mutiara 4* and *Jurong* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 10). Open dots represent outliers, not used for analysis.
[Gambar 16. (A) Gambaran nilai ekstrim ikan manyung, Netuma thalassina, *di Indonesia berdasarkan data dari kapal-kapal penelitian* Mutiara 4 *dan* Jurong *menunjukkan nilai maksimum dari 5 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 83.0 ± 11.0 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 26 contoh frekuensi-panjang ikan manyung,* Netuma thalassina, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4 *dan* Jurong *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 10). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

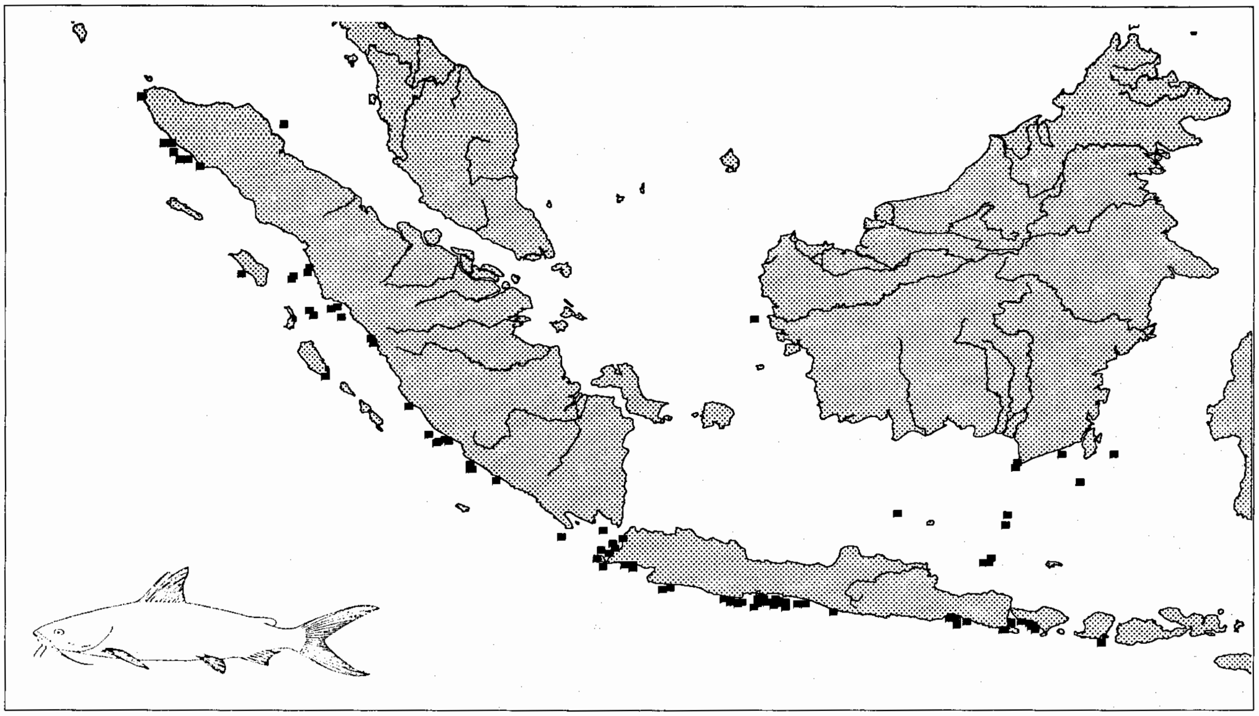

Fig. 17. Distribution of giant catfish, *Netuma thalassina*, in Western Indonesia based on records of the surveys of *R/Vs Mutiara 4, Bawal Putih 2, Dr. Fridtjof Nansen*, and *Jurong.*
[Gambar 17. Penyebaran ikan manyung, Netuma thalassina, *di Indonesia bagian barat berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Dr. Fridtjof Nansen *dan* Jurong.*]*

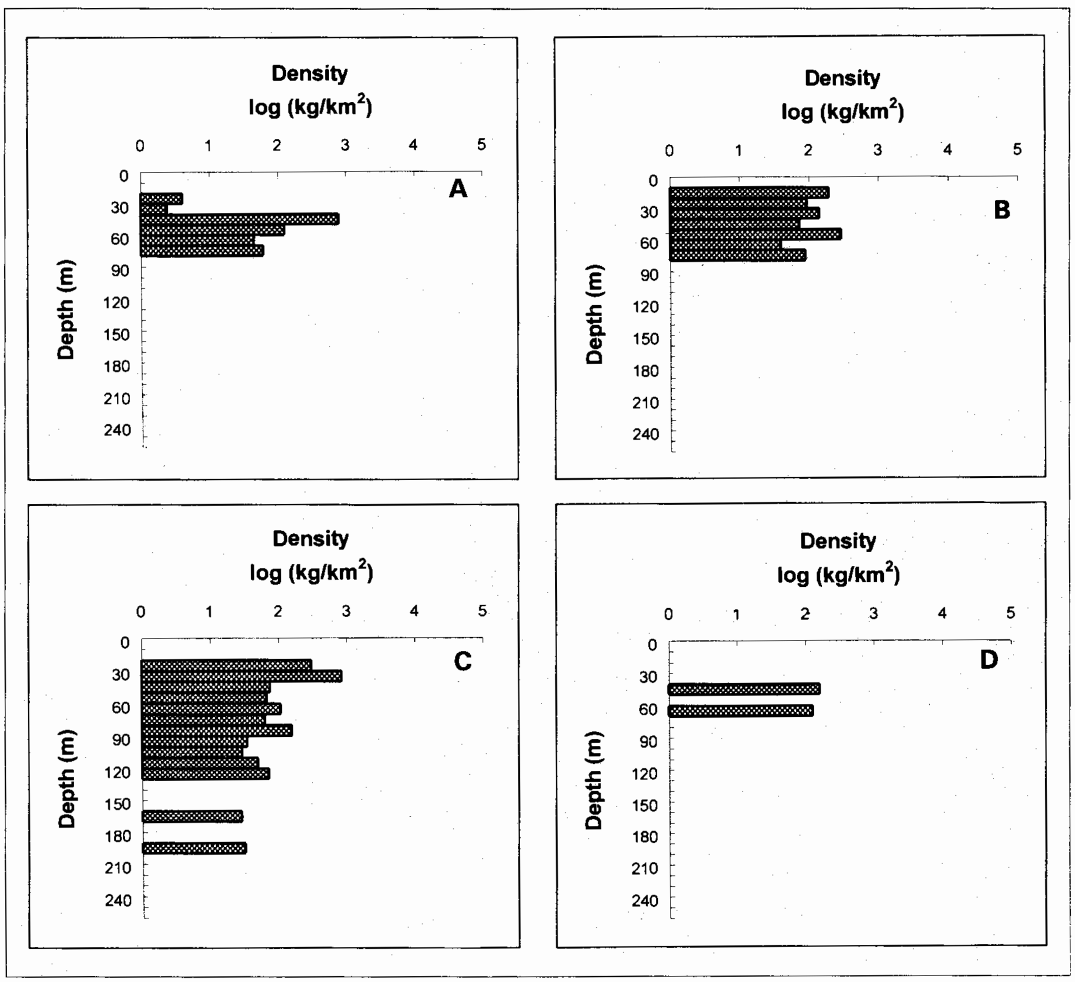

Fig. 18. Depth distribution of giant catfish, *Netuma thalassina*, in Western Indonesia based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen,* (B) *Mutiara 4,* (C) *Jurong* and (D) *Bawal Putih 2.*
[Gambar 18. Penyebaran kedalaman ikan manyung, Netuma thalassina, *di Indonesia bagian barat berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen, *(B)* Mutiara 4, *(C)* Jurong *dan (D)* Bawal Putih 2.*]*

Saurida micropectoralis (Shindo & Yamada, 1972)

Shortfin lizardfish (English); Beloso sirip pendek (Indonesian).

Body elongate, cylindrical. Back and upper sides brown, lower sides and belly white. Nine to ten faint blotches along the lateral line, sometimes with traces of very indistinct cross-bars on the back. Dorsal spines: -; soft rays: -; anal spines: -; soft rays: -. L_{max1} = 38 cm; L_{max2}= n.a.; L_{max3} = 49.7 cm FL (Fig. 19A). See Fig. 19B and Table 12 for length-weight relationship.

Indo-West Pacific: Andaman and South China Sea, Indonesia (Fig. 20); south to northern Australia.

Occurs over muddy bottoms from 20 to 260 m (Fig. 21). Feeds on small bottom-dwelling invertebrates and fishes. Table 13 presents a set of growth parameters from Indonesia.

References: 393, 1314, 2117, 2857, 4749, 4789, 5756

Table 12. Length-weight (g/[FL;cm]) relationship of shortfin lizardfish, *Saurida micropectoralis*, in Indonesia.
[Tabel 12. Hubungan panjang-berat [g/(FL;cm)] ikan beloso sirip pendek, Saurida micropectoralis, *di Indonesia.]*

Parameter	Estimate
a	0.0050
s.e.(a)	0.0008
b	3.1959
s.e.(b)	0.0530
r^2	0.9988

Table 13. Growth parameters of shortfin lizardfish, *Saurida micropectoralis.*
[Tabel 13. Parameter pertumbuhan dari ikan beloso sirip pendek, Saurida micropectoralis.*]*

Parameter	A
L_∞ (TL, cm)	42.0
K ($year^{-1}$)	0.88

A. Java Sea (Central Java) (Ref. 1314)

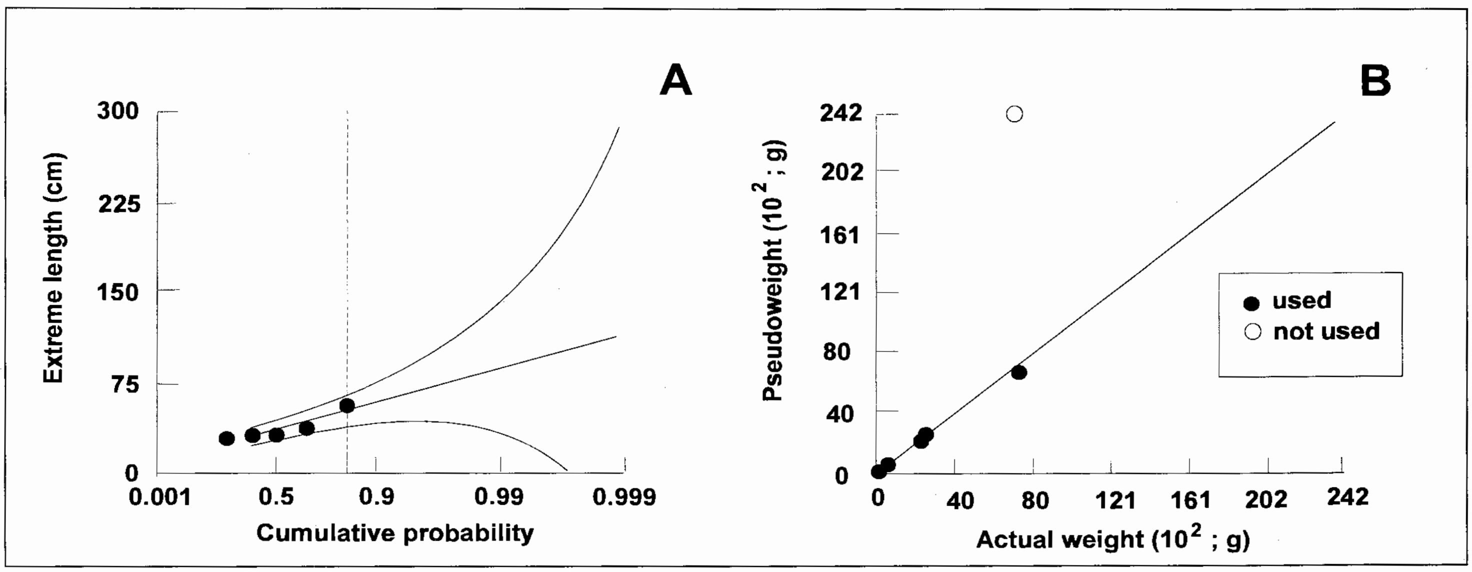

Fig. 19. (A) Extreme value plot for shortfin lizardfish, *Saurida micropectoralis,* in Indonesia based on data from *R/Vs Mutiara 4* and *Jurong*, showing maxima of 5 length-frequency samples, and estimate of L_{max3} = 49.7 ± 12.8 cm FL. (B) Predicted *vs.* observed weights (in g wet weight) of 7 length-frequency samples of shortfin lizardfish, *Saurida micropectoralis,* from Western Indonesia based on data from *R/Vs Mutiara 4* and *Jurong* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 12). Open dot represents outlier, not used for analysis.
[Gambar 19. (A) Gambaran nilai ekstrim untuk ikan beloso sirip pendek, Saurida micropectoralis, *di Indonesia berdasarkan data dari kapal-kapal penelitian* Mutiara 4 *dan* Jurong, *menunjukkan nilai maksimum dari 5 contoh frekuensi-panjang, dan nilai perkiraan L_{max3} = 49.7 ± 12.8 cm FL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 7 contoh frekuensi-panjang ikan beloso sirip pendek,* Saurida micropectoralis, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4 *dan Jurong sebagai output perangkat lunak ABee (lihat Boks 1), dan memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 12). Bulatan kosong mewakili suatu pengamatan yang tidak dipakai dalam analisis.]*

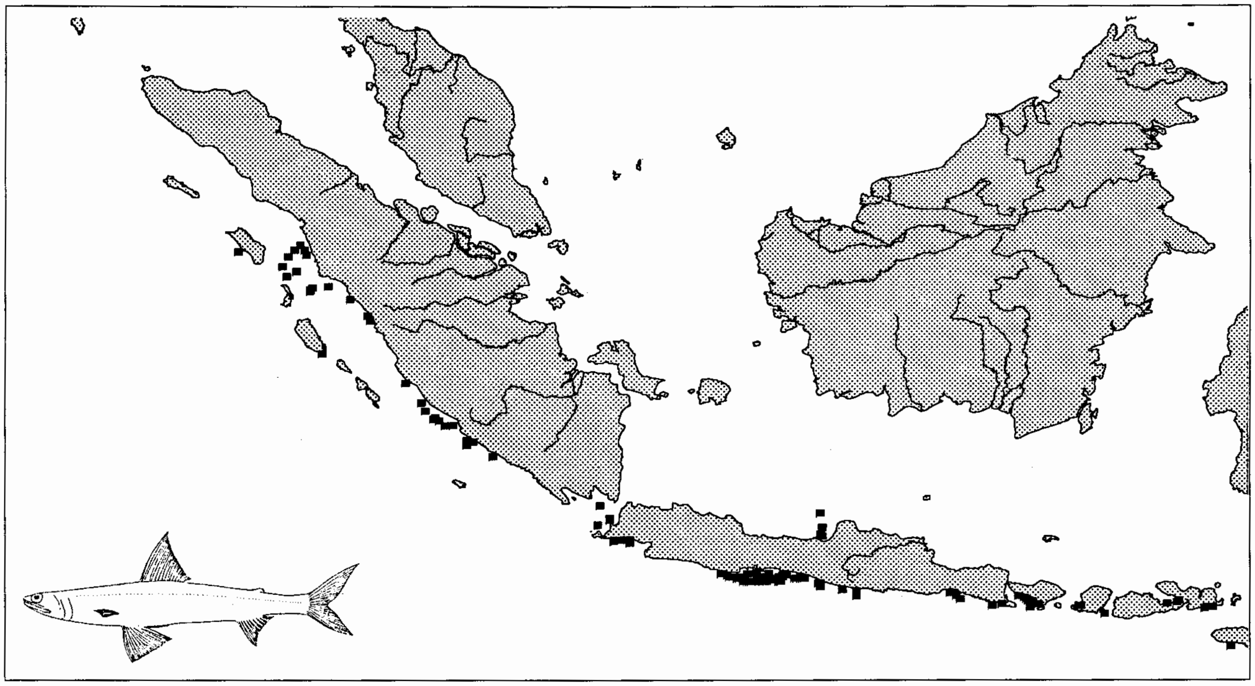

Fig. 20. Distribution of shortfin lizardfish, *Saurida micropectoralis*, in Western Indonesia based on records of the surveys of *R/Vs Mutiara 4, Bawal Putih 2* and *Jurong.*
[*Gambar 20. Penyebaran ikan beloso sirip pendek,* Saurida micropectoralis, *di Indonesia bagian barat berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Bawal Putih 2 *dan* Jurong.]

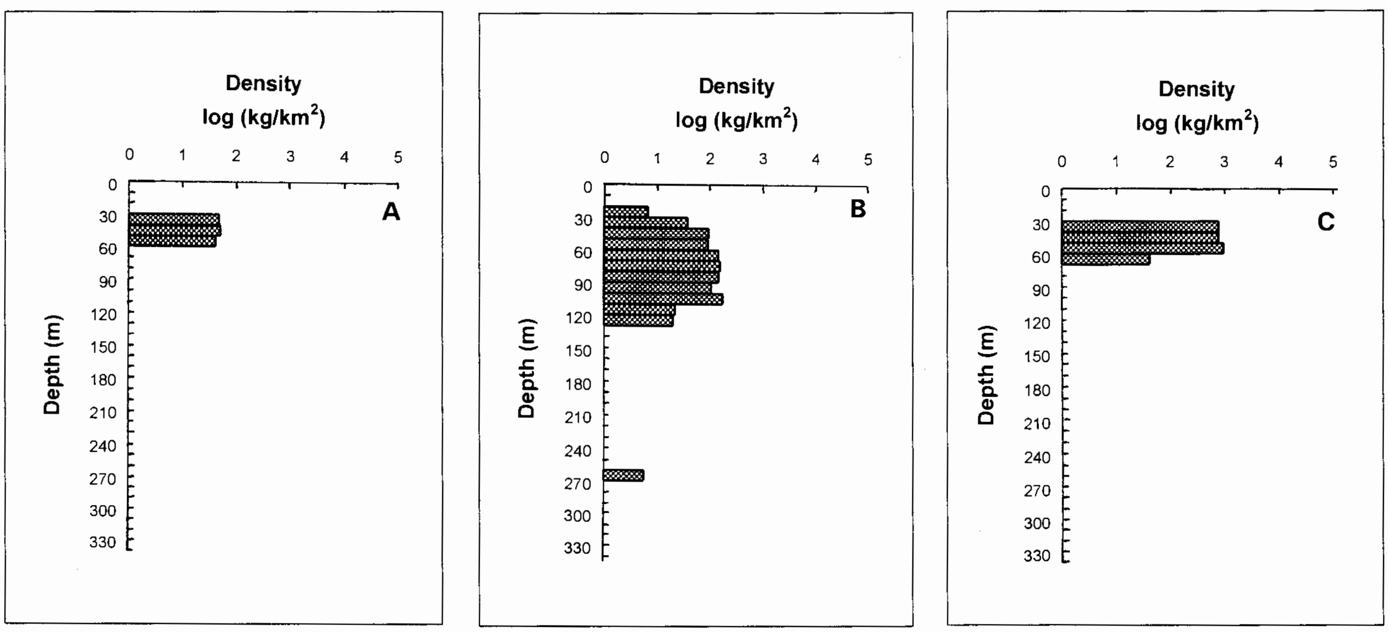

Fig. 21. Depth distribution of shortfin lizardfish, *Saurida micropectoralis*, in Western Indonesia based on surveys of *R/Vs* (A) *Mutiara 4,* (B) *Jurong* and (C) *Bawal Putih 2.*
[*Gambar 21. Penyebaran kedalaman dari ikan beloso sirip pendek,* Saurida micropectoralis, *di Indonesia bagian barat berdasarkan survei kapal-kapal penelitian (A)* Mutiara 4, *(B)* Jurong *dan (C)* Bawal Putih 2.]

Saurida undosquamis (Richardson, 1848)

Brushtooth lizardfish (English); Beloso (Indonesian).

Cigar-shaped, rounded or slightly compressed; the head pointed and depressed; the snout rounded. Color is brown-gray above and creamy below, with 8-10 indistinct darker spots alongthe middle of the sides. Dorsal spines: 0-0; soft rays: 11-12; anal spines: 0-0; soft rays: 11-12. L_{max1}= 50 cm. SL; L_{max2}= n.a.; L_{max3}= 41.45 cm TL (Fig. 22A). See Fig. 22B and Table 14 for length-weight relationship.

Indo-West Pacific from South Africa, through Indonesia (Fig. 23) to Japan and Western Australia (Great Barrier Reef). Migrated from the Red Sea through the Suez Canal to the eastern Mediterranean.

Found over muddy substrates of coastal waters, from about 20-290 m (Fig. 24). Feeds on fishes, crustaceans, and other invertebrates. Table 15 presents a set of growth parameters from Indonesia.

References: 231, 312, 1139, 1263, 1288, 1289, 1314, 1449, 1474, 1486, 1488, 1498, 1524, 1532, 2178, 2857, 2877, 3397, 3557, 3626, 3670, 3674, 3675, 3676, 3678, 4055, 4595, 4789, 4964, 5193 5213, 5284, 5337, 5381, 5385, 5450, 5525, 5736, 5756, 5760, 5829, 6313, 6328, 6365, 6567

Table 14. Length-weight (g/[TL;cm]) relationship of brushtooth lizardfish, *Saurida undosquamis,* in Indonesia.
[Tabel 14. Hubungan panjang-berat (g/[TL;cm]) ikan beloso, Saurida undosquamis, *di Indonesia.]*

Parameter	Estimate
a	0.0027
s.e.(a)	0.0017
b	3.3200
s.e.(b)	0.1918
r^2	0.9601

Table 15. Growth parameters of brushtooth lizardfish, *Saurida undosquamis.*
[Tabel 15. Parameter pertumbuhan ikan beloso, Saurida undosquamis.*]*

Parameter	A
L_∞ (TL, cm)	33.5
K (year^{-1})	0.95

A. Java Sea (Central Java) (Ref. 1314)

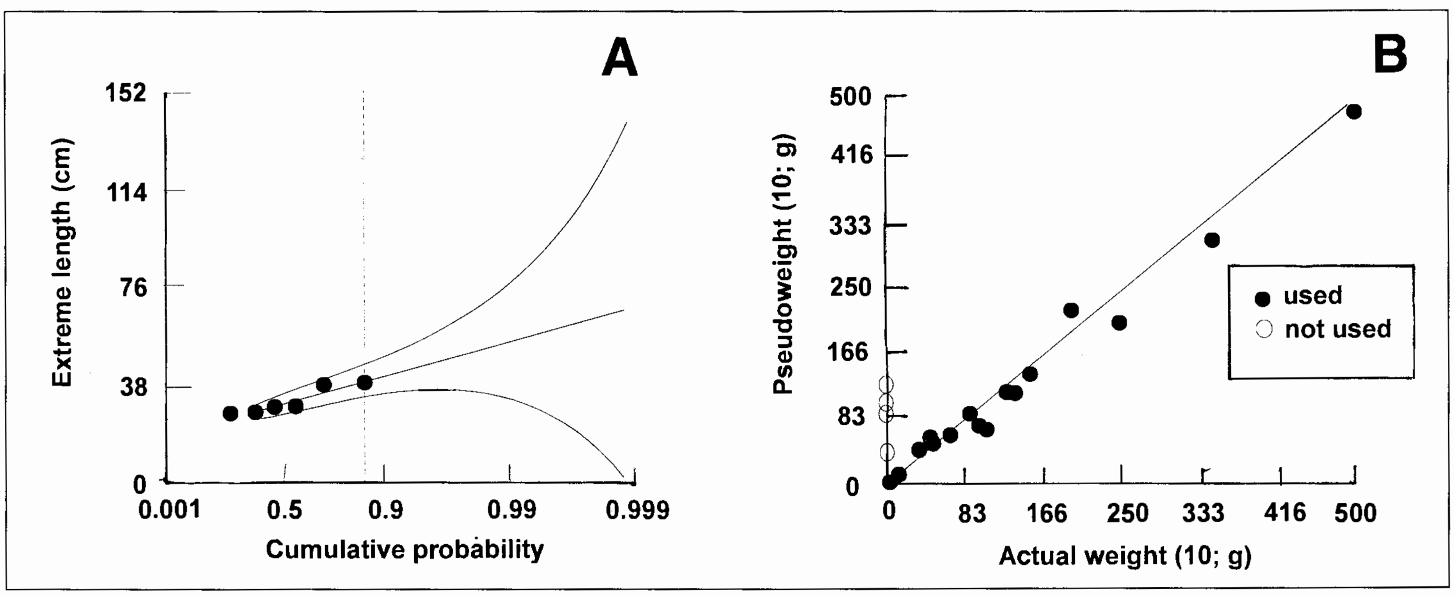

Fig. 22. (A) Extreme value plot for brushtooth lizardfish, *Saurida undosquamis,* in Indonesia based on data from *R/Vs Mutiara 4* and *Jurong,* showing maxima of 6 length-frequency samples, and estimate of L_{max3} = 41.45 $\pm$ 5.92 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 18 length-frequency samples of brushtooth lizardfish, *Saurida undosquamis,* from Western Indonesia based on data from *R/Vs Mutiara 4* and *Jurong* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 14). Open dots represent outliers, not used for analysis. *[Gambar 22. (A) Gambaran nilai ekstrim untuk ikan beloso,* Saurida undosquamis, *di Indonesia berdasarkan data dari kapal-kapal penelitian* Mutiara 4 *dan* Jurong *menunjukkan nilai maksimum 6 contoh frekuensi-panjang, dan nilai perkiraan L_{max3} = 41.45 $\pm$ 5.92 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 18 contoh frekuensi-panjang ikan beloso,* Saurida undosquamis, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4 *dan* Jurong *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 14). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

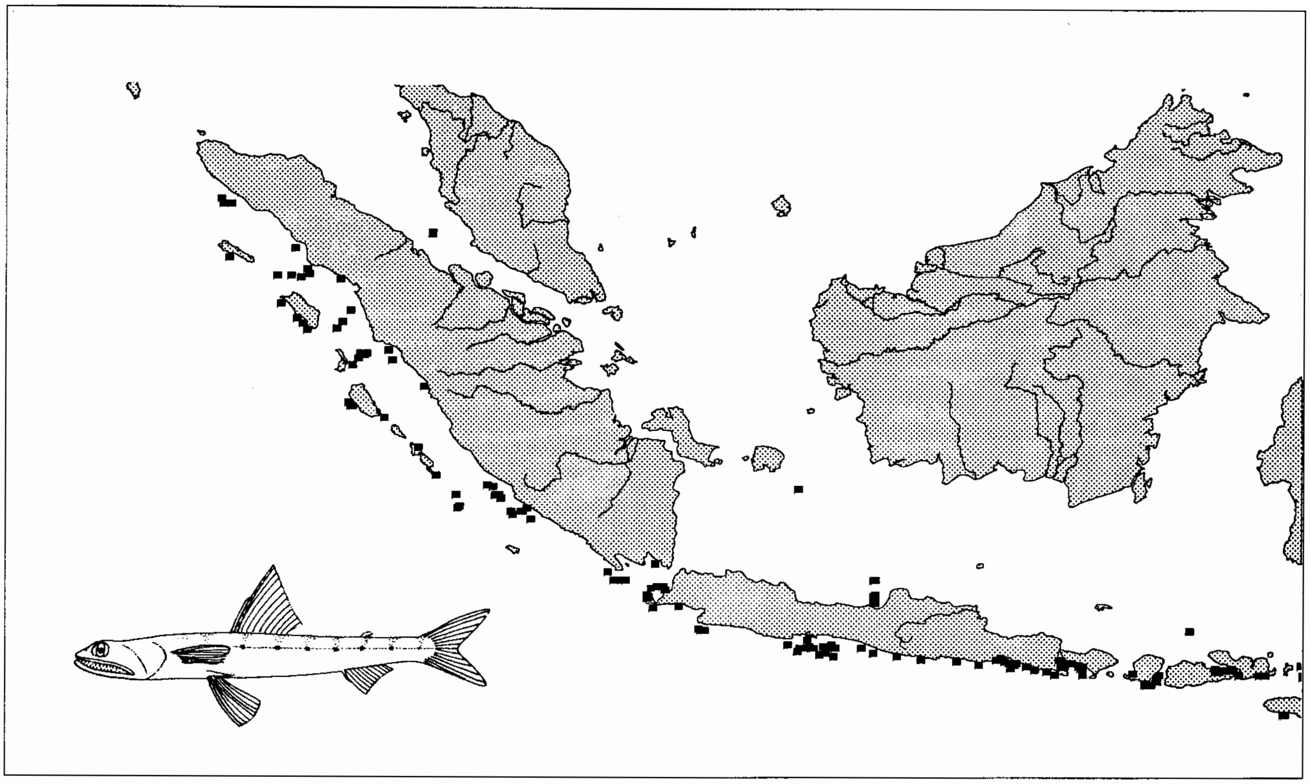

Fig. 23. Distribution of brushtooth lizardfish, *Saurida undosquamis*, in Western Indonesia based on records of the surveys of *R/Vs Dr. Fridtjof Nansen, Mutiara 4, Jurong* and *Bawal Putih 2.*
[Gambar 23. Penyebaran ikan beloso, Saurida undosquamis, *di Indonesia bagian barat berdasarkan laporan survei kapal-kapal penelitian* Dr. Fridtjof Nansen, Mutiara 4, Jurong *dan* Bawal Putih 2.*]*

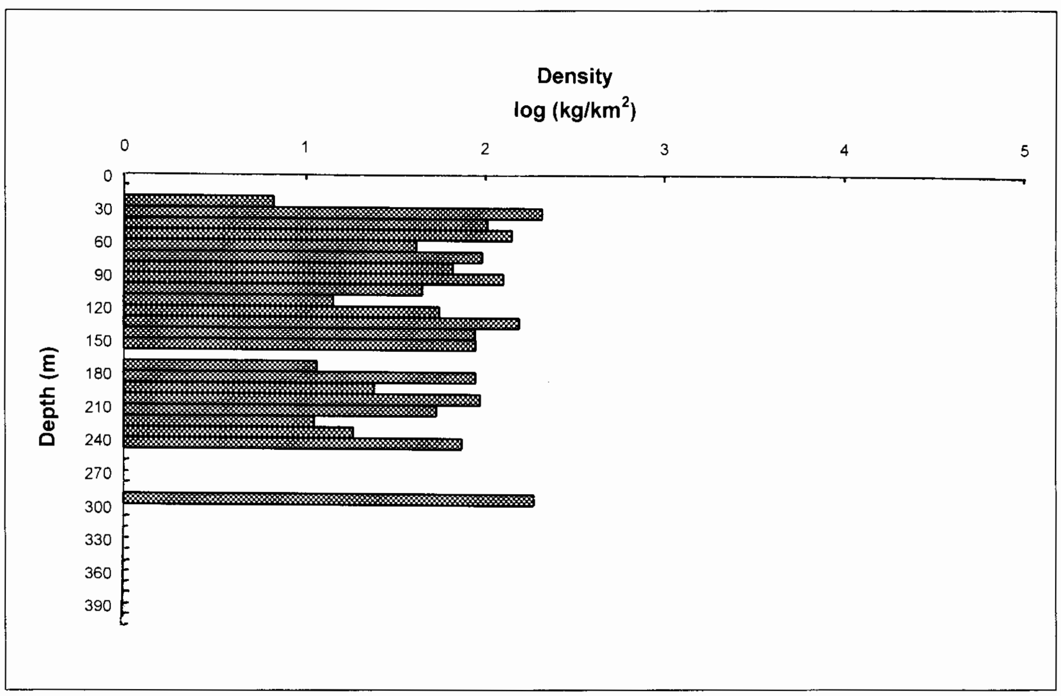

Fig. 24. Depth distribution of brushtooth lizardfish, *Saurida undosquamis*, in Western Indonesia based on surveys of *R/V Jurong*.
[Gambar 24. Penyebaran kedalaman ikan beloso, Saurida undosquamis, *di Indonesia bagian barat berdasarkan survei kapal penelitian* Jurong.*]*

Carangoides malabaricus (Bloch & Schneider, 1801)

Malabar trevally (English); Karang trevali, Kuwe (Indonesian).

Silvery, bluish gray dorsally. Opercle with a small, black spot. Lateral line with 19-36 weak scutes. Pectoral fins falcate; first dorsal lobe slightly falcate. No scales on breast to behind pelvic origin and laterally to pectoral base, including the small area anteriorly just above fin. Dorsal spines: 9 - 9; soft rays: 20-23; anal spines: 3-3; soft rays: 17-19. L_{max1}= 60 cm; L_{max2}= n.a.; L_{max3}= 29.18 cm TL (Fig. 25A). See Fig. 25B and Table 16 for length-weight relationship.

Ranges from the east coast of Africa (without verified records from the Red Sea) to Sri Lanka and farther eastward to the Gulf of Thailand and Indonesia (Fig. 26), north to Okinawa (Japan) and south to Australia.

Found near rocks and coral reefs. Depth range: 20-110 m (Fig. 27). Juveniles inhabit sandy bays. Feeds on crustaceans, small squids and fish.

References: 280, 1449, 2334, 2857, 3280, 3287, 3605, 5213, 5450, 5736, 5756, 6313, 6365, 6567

Table 16. Length-weight [g/(TL;cm)] relationship of Malabar trevally, *Carangoides malabaricus*, in Indonesia.
[Tabel 16. Hubungan panjang-berat [g/(TL;cm)] ikan karang trevali, Carangoides malabaricus, *di Indonesia.]*

Parameter	Estimate
a	0.0205
s.e.(a)	0.0120
b	2.8476
s.e.(b)	0.1953
r^2	0.9796

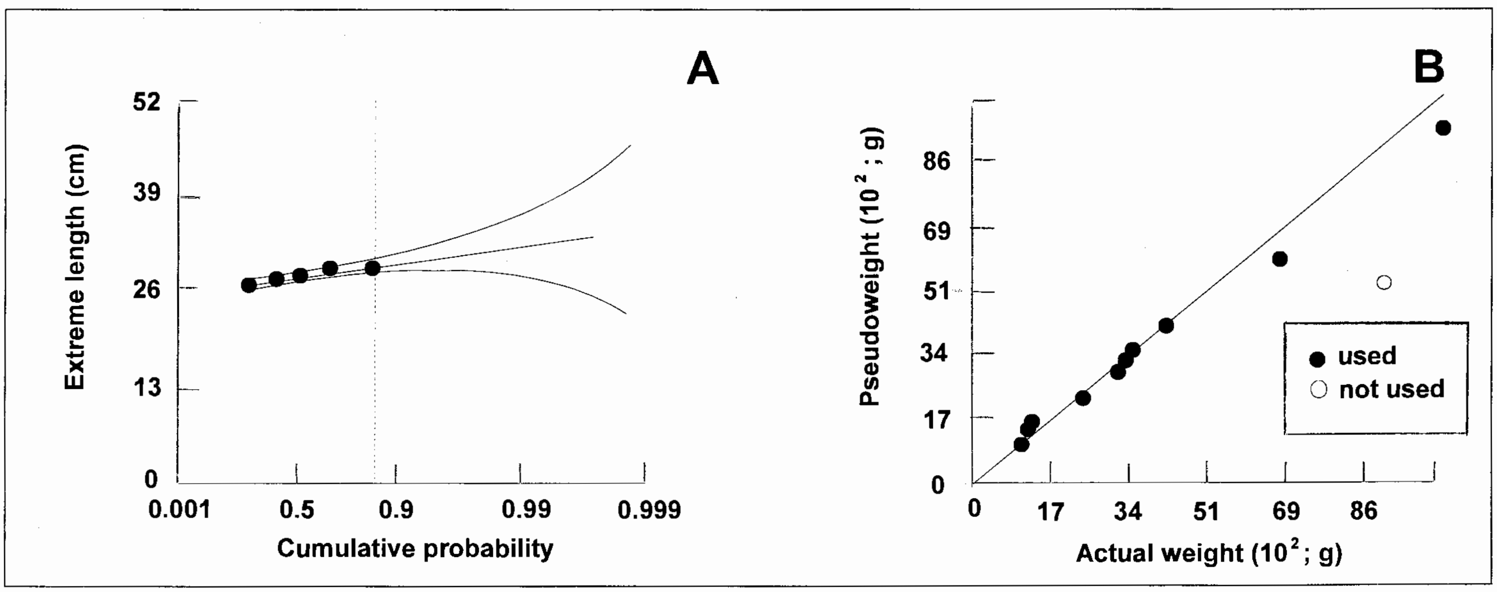

Fig. 25. (A) Extreme value plot for Malabar trevally, *Carangoides malabaricus*, in Indonesia based on data from *R/Vs Dr. Fridtjof Nansen* and *Jurong*, showing maxima of 5 length-frequency samples, and estimate of L_{max3} = 29.18 ± 0.945 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 10 length-frequency samples of Malabar trevally, *Carangoides malabaricus*, from Western Indonesia based on data from *R/Vs Mutiara 4, Dr. Fridtjof Nansen* and *Jurong* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 16). Open dot represents outlier, not used for analysis.

[Gambar 25. (A) Gambaran nilai ekstrim dari ikan karang trevali, Carangoides malabaricus, *di Indonesia berdasarkan data dari kapal-kapal penelitian* Dr. Fridtjof Nansen *dan* Jurong, *yang menunjukkan angka maksimum dari 5 contoh frekuensi-panjang, dan nilai perkiraan L_{max3} = 29.18 ± 0.945 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 10 contoh frekuensi-panjang ikan karang trevali,* Carangoides malabaricus, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Dr. Fridtjof Nansen *dan* Jurong *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 16). Bulatan kosong mewakili suatu pengamatan yang tidak dipakai dalam analisis.]*

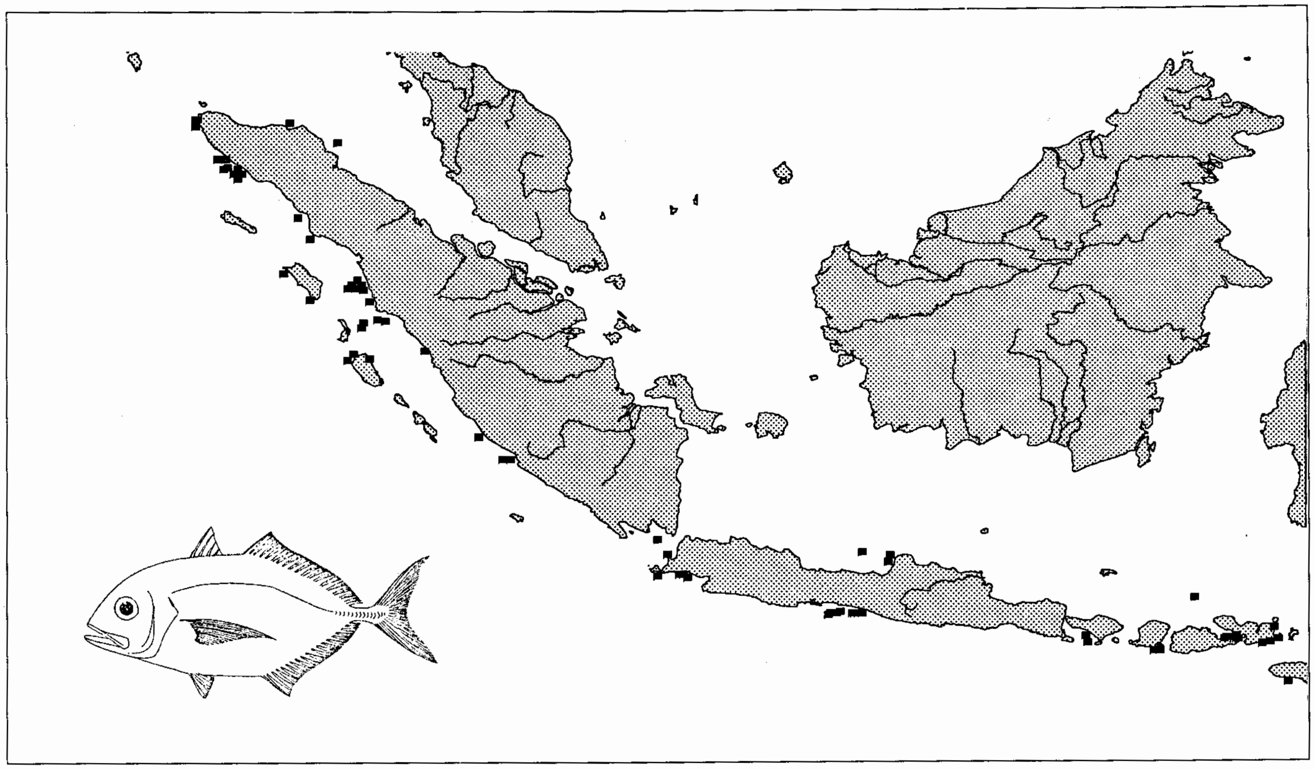

Fig. 26. Distribution of Malabar trevally, *Carangoides malabaricus,* in Western Indonesia based on records of the surveys of *R/Vs Dr. Fridtjof Nansen, Mutiara 4, Jurong* and *Bawal Putih 2.*

[Gambar 26. Penyebaran ikan karang trevali, Carangoides malabaricus, *di Indonesia bagian barat berdasarkan laporan survei kapal-kapal penelitian* Dr. Fridtjof Nansen, Mutiara 4, Jurong *dan* Bawal Putih 2.*]*

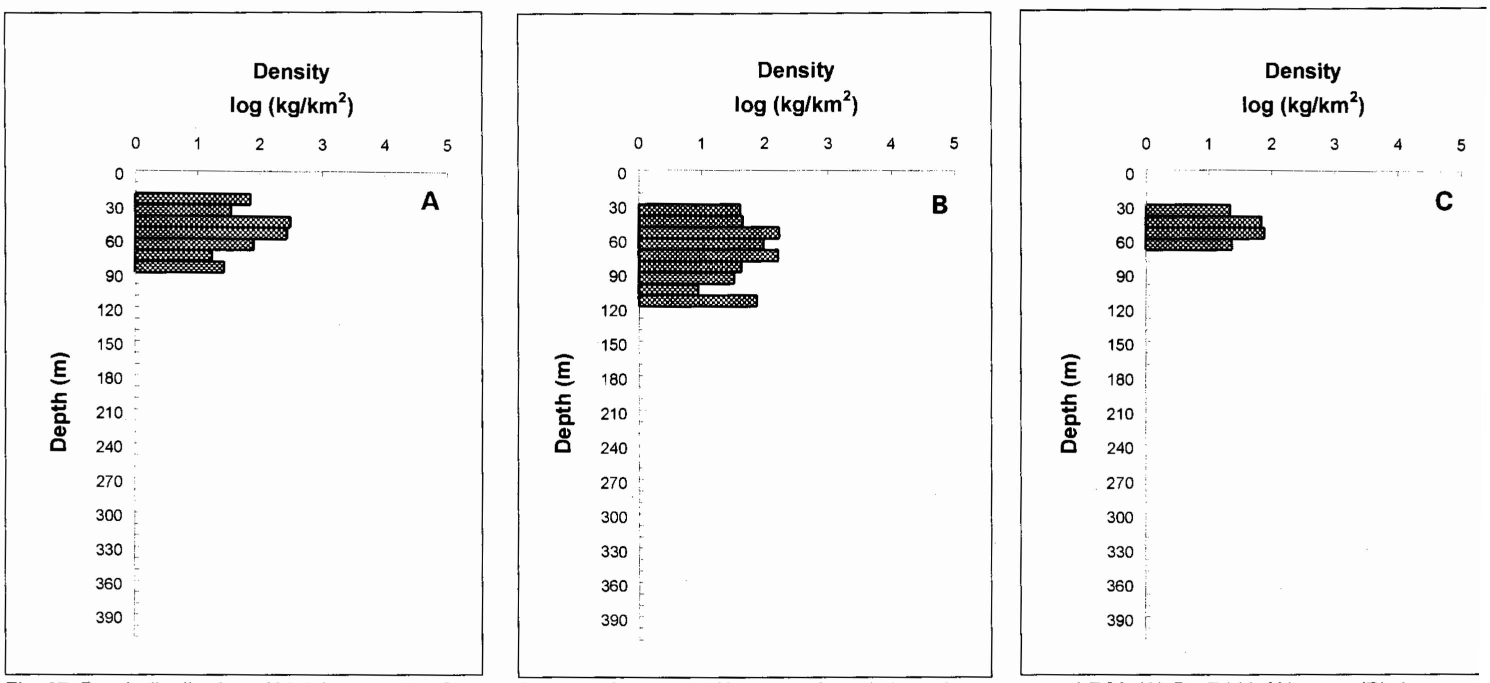

Fig. 27. Depth distribution of Malabar trevally, *Carangoides malabaricus*, in Western Indonesia based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen*, (B) *Jurong* ar (C) *Bawal Putih 2.*

[Gambar 27. Penyebaran kedalaman ikan karang trevali, Carangoides malabaricus, *di Indonesia bagian barat berdasarkan survei kapal-kapal penelitian (A)* D Fridtjof Nansen, *(B)* Jurong *dan (C)* Bawal Putih 2.*]*

Caranx ignobilis (Forsskål, 1775)

Giant trevally (English); Karang besar (Indonesian).

Head and body dusky golden dorsally, silver ventrally; fins usually pigmented gray to black. Opercular spot absent. Twenty-six to 38 strong scutes. Breast scaleless ventrally; a small patch of prepelvic scales. Pectoral fins falcate; anal fin with 2 detached spines. Dorsal spines: 9-9; soft rays: 17-22; anal spines: 3-3; soft rays: 15-17. L_{max1} = 165 cm FL; L_{max2} = n.a.; L_{max3} = 57.2 cm FL (Fig. 28A). See Fig. 28B and Table 17 for length-weight relationship.

Widely distributed throughout most of the Indian Ocean, the Indonesian Archipelago (Fig. 29) and the Central Pacific, eastward to the Hawaiian and Marquesas Islands.

Juveniles are found in small schools over sandy inshore bottoms, adults usually solitary, over the reef. Depth range 20-100 m (Fig. 30). Usually feeds at night on fishes and crustaceans such as crabs and spiny lobsters. Large individuals may be ciguatoxic.

References: 171, 583, 1602, 2334, 2857, 2872, 3280, 3287, 3605, 3626, 3678, 3804, 3807, 4332, 4362, 4390, 4560, 4699, 4735, 4795, 4821, 4887, 4917, 4959, 5213, 5450, 5525, 5736, 5756, 5970, 6026, 6057, 6273, 6306, 6313, 6365

Table 17. Length-weight (g/[FL;cm]) relationship of giant trevally, *Caranx ignobilis,* in Indonesia.
[Tabel 17. Hubungan panjang-berat (g/[FL;cm]) ikan karang besar, Caranx ignobilis, *di Indonesia.]*

Parameter	Estimate
a	0.0202
s.e.(a)	n.a.
b	3.0000
s.e.(b)	n.a.
r^2	0.0000

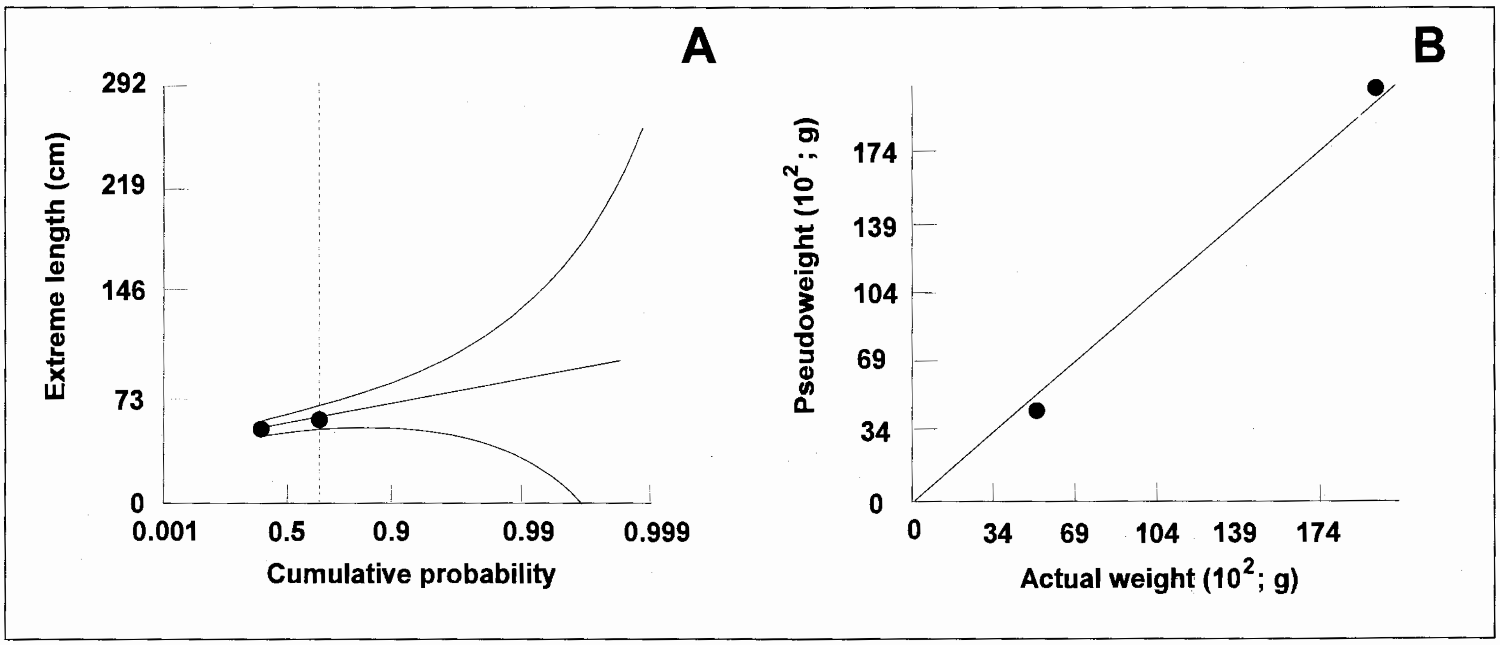

Fig. 28. (A) Extreme value plot for giant trevally, *Caranx ignobilis,* in Indonesia based on data from *R/V Jurong*, showing maxima of 2 length-frequency samples, and estimate of L_{max3} = 57.2 ± 8.2 cm FL. (B) Predicted *vs.* observed weights (in g wet weight) of 2 length-frequency samples of giant trevally, *Caranx ignobilis,* from Western Indonesia based on data from *R/V Jurong* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 17).
[Gambar 28. (A) Penggambaran nilai ekstrim ikan karang besar, Caranx ignobilis, *di Indonesia berdasarkan data dari kapal penelitian* Jurong, *yang menunjukkan nilai maksimum dari 2 contoh frekuensi-panjang, dan nilai perkiraan L_{max3} = 57.2 ± 8.2 cm FL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 2 contoh frekuensi-panjang ikan karang besar,* Caranx ignobilis, *dari Indonesia bagian barat berdasarkan data kapal penelitian* Jurong *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 17).*

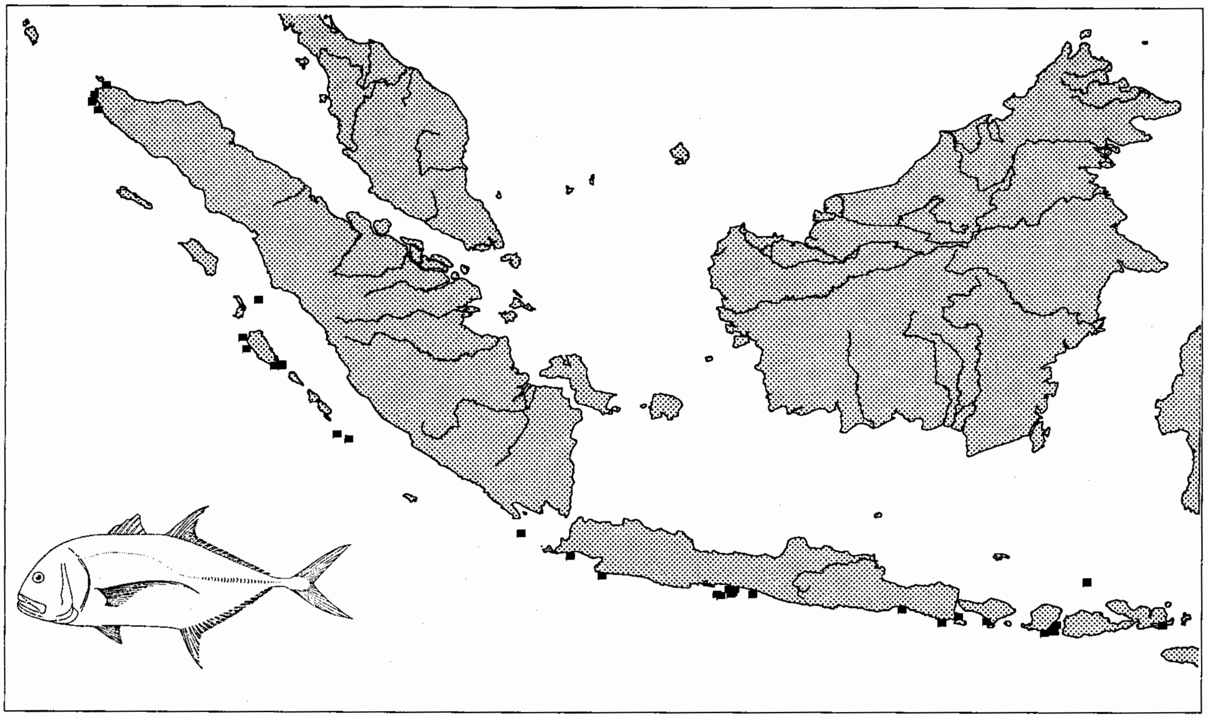

Fig. 29. Distribution of giant trevally, *Caranx ignobilis*, in Western Indonesia based on records of the surveys of *R/Vs Dr. Fridtjof Nansen, Jurong* and *Bawal Putih 2.*
[Gambar 29. Penyebaran ikan karang besar, Caranx ignobilis*, di Indonesia bagian barat berdasarkan laporan dari survei kapal-kapal penelitian* Dr. Fridtjof Nansen, Jurong *dan* Bawal Putih 2.*]*

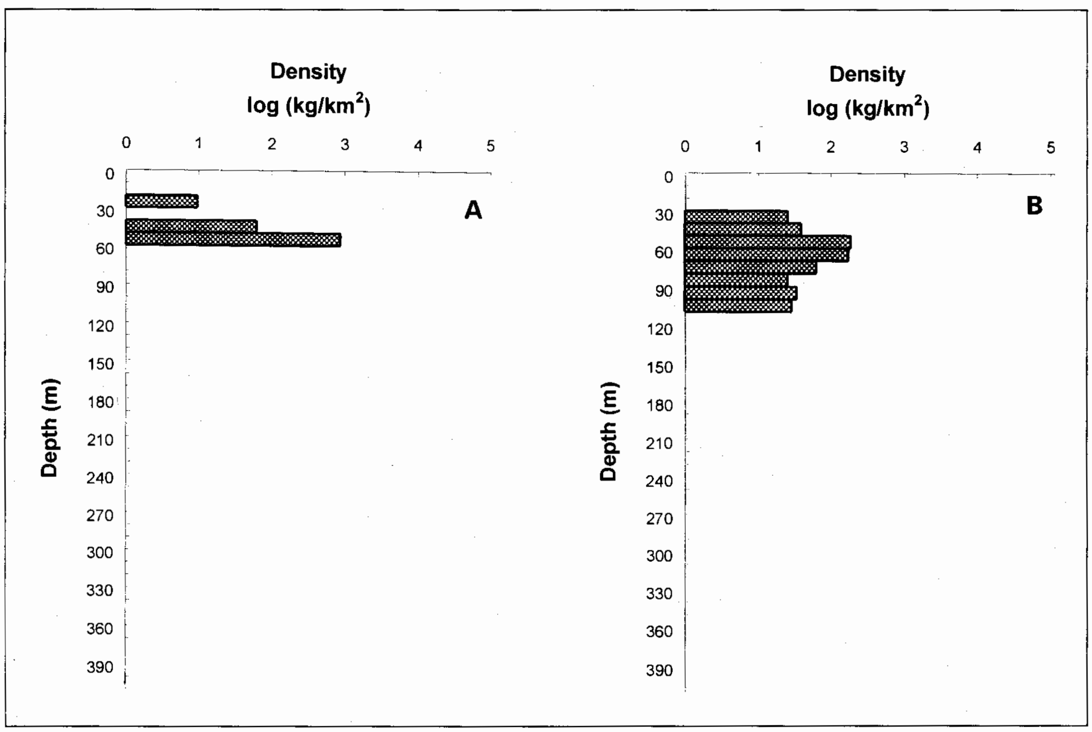

Fig. 30. Depth distribution of giant trevally, *Caranx ignobilis*, in Western Indonesia based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen* and (B) *Jurong.*
[Gambar 30. Penyebaran kedalaman ikan karang besar, Caranx ignobilis*, di Indonesia bagian barat berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen *dan (B)* Jurong.*]*

Caranx tille (Cuvier, 1833)

Tille trevally (English); Karang tile (Indonesian).

Body dark olive green to bluish gray dorsally, silvery white below; soft dorsal lobe olive gray to blackish. Upper part of opercle with a small blackish spot. Thirty-three to 42 strong scutes. Pectoral fins falcate. Two anal fin spines detached. Breast fully scaled. Dorsal spines: 9-9; soft rays: 20-22; anal spines: 3-3; soft rays: 16-18. L_{max1} = 80 cm; L_{max2} = n.a.; L_{max3} = 54.5 cm FL (Fig. 31A). See Fig. 31B and Table 18 for length-weight relationship.

Distribution in the Indian Ocean not well established; reported from Durban to Zanzibar; also recorded in Madagascar and Sri Lanka. Ranges from Indonesia (Fig. 32) to southern Japan (Okinawa), Australia and Fiji.

Inhabits coastal waters, near coral reefs and rocks. Depth range: 30 to 120 m (Fig. 33). Feeds on fish and crustaceans.

References: 171, 2334, 2857, 3197, 3280, 3807, 5193, 5213

Table 18. Length-weight (g/[FL;cm]) relationship of tille trevally, *Caranx tille*, in Indonesia.
Tabel 18. Hubungan panjang-berat (g/[FL;cm]) dari ikan karang tile, Caranx tille, *di Indonesia.*

Parameter	Estimate
a	0.0088
s.e.(a)	0.0092
b	3.1630
s.e.(b)	0.2859
r^2	0.9928

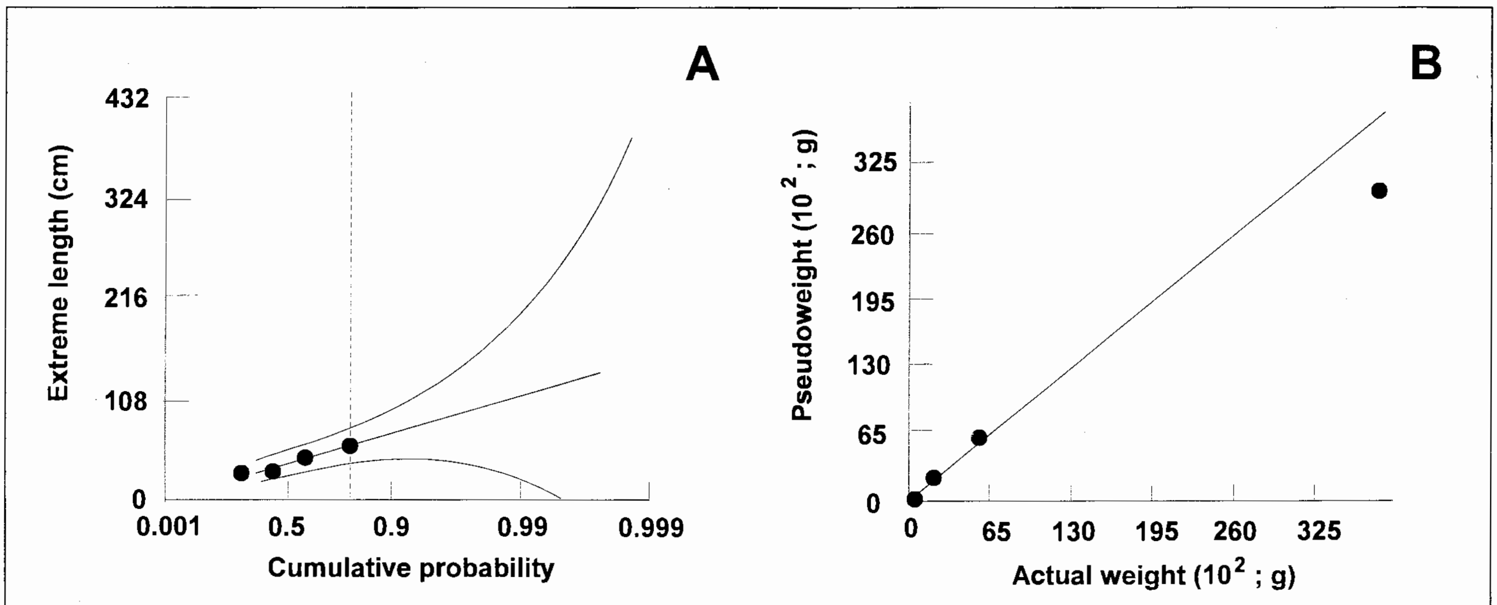

Fig. 31. (A) Extreme value plot for tille trevally, *Caranx tille*, in Indonesia based on data from *R/V Jurong*, showing maxima of 4 length-frequency samples, and estimate of L_{max3} = 54.5 ± 17.6 cm FL. (B) Predicted *vs.* observed weights (in g wet weight) of 4 length-frequency samples of tille trevally, *Caranx tille*, from Western Indonesia based on data from *R/V Jurong* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 18).

[Gambar 31. (A) Penggambaran nilai ekstrim ikan karang tile, Caranx tille, *di Indonesia berdasarkan data dari kapal penelitian* Jurong, *menunjukkan nilai maksimum dari 4 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 54.5 ± 17.6 cm FL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 4 contoh frekuensi-panjang ikan karang tile,* Caranx tille, *dari Indonesia bagian barat berdasarkan data kapal penelitian* Jurong *sebagai output perangkat lunak ABee (lihat Boks 1), yang memungkinkan estimasi hubungan panjang-berat (lihat Tabel 18).*

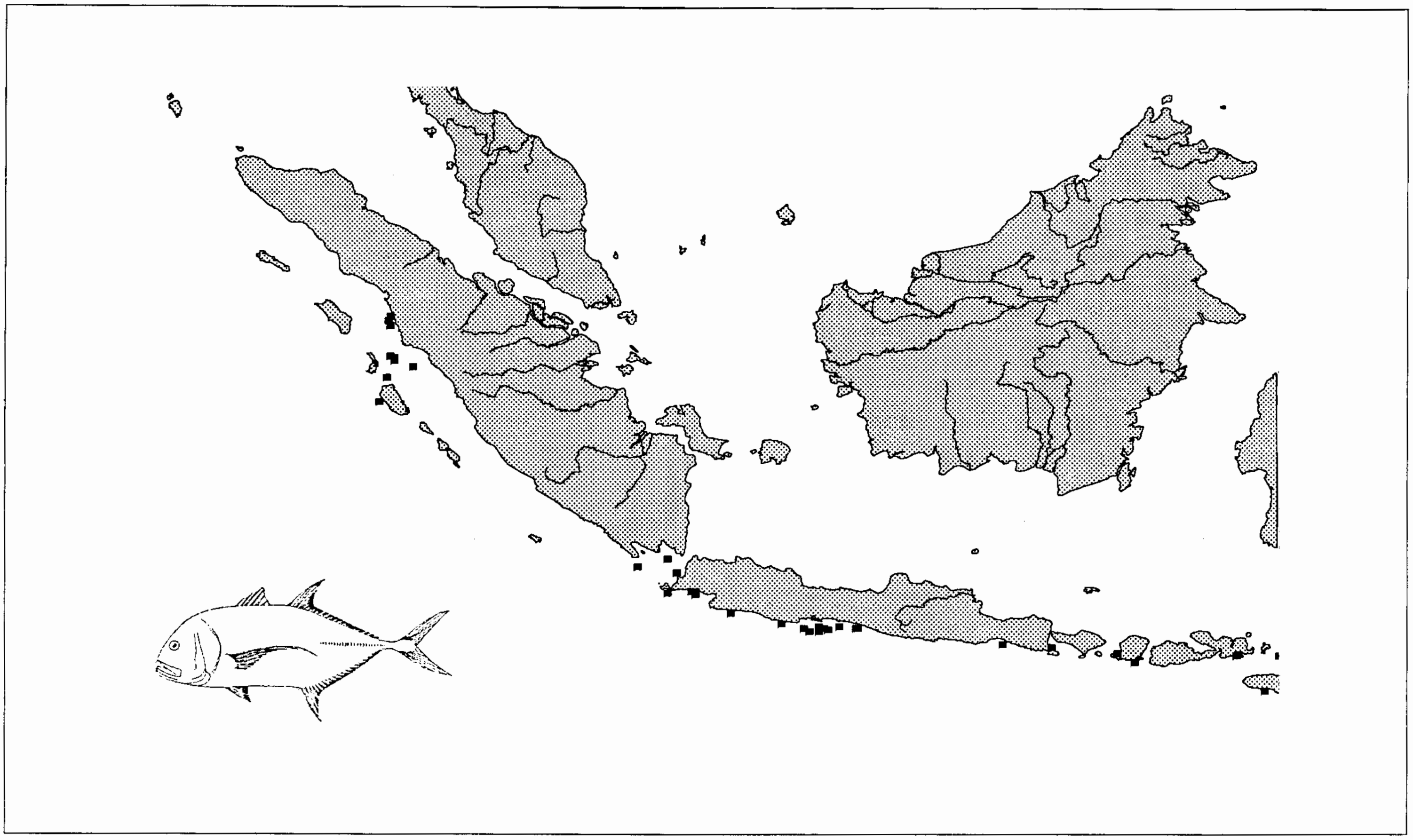

Fig. 32. Distribution of tille trevally, *Caranx tille*, in Western Indonesia based on records of the surveys of *R/Vs Jurong* and *Bawal Putih 2.*
[Gambar 32. Penyebaran ikan karang tile, Caranx tille*, di Indonesia bagian barat berdasarkan laporan survei kapal-kapal penelitian* Jurong *dan* Bawal Putih 2.*]*

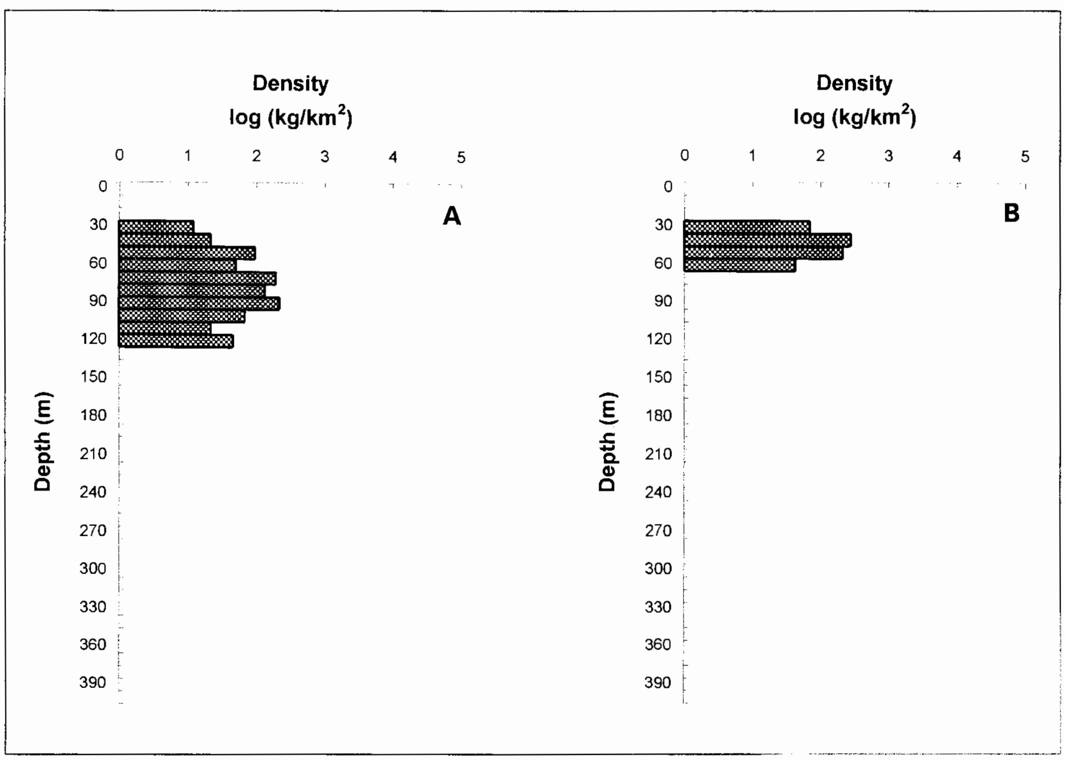

Fig. 33. Depth distribution of tille trevally, *Caranx tille*, in Western Indonesia based on surveys of *R/Vs* (A) *Jurong,* and (B) *Bawal Putih 2.*
[Gambar 33. Penyebaran kedalaman ikan karang tile, Caranx tille*, di Indonesia bagian barat berdasarkan survei kapal-kapal penelitian (A)* Jurong *dan (B)* Bawal Putih 2.*]*

Decapterus macrosoma (Bleeker, 1851)

Shortfin scad (English); Lajang deles (Indonesian); Bengol deles, Deles, Lajang, Lajang deles, Lajang lidi, Luntju (Java); Lajang (West Java, Jakarta); Bulus blangseng, Kaban bulus, Kaban laes, Kaban padara, Kaban patek, Ladjeng lakek, Rentjek bulus, Rentjek kaban (Madura); Bulus (Bawean).

Metallic blue dorsally, silvery ventrally; fins hyaline. Opercle with a small black spot. Anal fin with 2 detached spines. Twenty-four to 40 scutes. Upper jaw reaching below front margin of eye. Dorsal spines: 9-9; soft rays: 33-38; anal spines: 3-3; soft rays: 27-30. L_{max1} = 35 cm; L_{max2} = 20 cm ; L_{max3} = 28.95 cm TL (Fig. 34A). See Fig. 34B and Table 19 for length-weight relationship.

Pacific Ocean: from southern Japan to warm waters of the Western Pacific, including the Indonesian Archipelago (Fig. 35). Eastern Pacific: from the Gulf of California, Mexico to Peru, including the Galapagos Islands.

Forms schools. Depth range: 20-140 m (Fig. 36). Feeds on small invertebrate plankton. Table 20 presents six sets of growth parameters from Indonesia.

References: 171, 312, 559, 761, 1263, 1314, 1386, 1392, 1447, 1449, 1462, 1467, 1602, 2021, 2023, 2334, 2857, 3280, 3287, 3555, 3556, 3786, 3804, 3807, 4536, 4789, 4838, 5213, 5337, 5340, 5530, 5730, 5756, 6313, 6365

Table 19. Length-weight (g/[TL;cm]) relationship of shortfin scad, *Decapterus macrosoma*, in Indonesia.
[Tabel 19. Hubungan panjang-berat (g/[TL;cm]) ikan layang deles, Decapterus macrosoma, *di Indonesia.]*

Parameter	A	B
a	0.0076	0.009
s.e.(a)	0.0125	n.a.
b	3.0051	3.01
s.e.(b)	0.5630	n.a.
r^2	0.8669	n.a.

A. This study.
B. Java Sea (Ref. 1386).

Table 20. Growth parameters of shortfin scad, *Decapterus macrosoma*.
[Tabel 20. Parameter pertumbuhan ikan layang deles, Decapterus macrosoma.*]*

Parameter	A	B	C	D	E	F
L_∞ (cm)	24.0	24.0	25.4	25.6	25.7	27.7
K ($year^{-1}$)	1.15	1.00	0.98	1.05	0.90	1.20

A. Java Sea (Ref. 1386), L in FL.
B. Asahan, Sumatra (Ref. 1467).
C. Java Sea (Pekalongan) (Ref. 1314), L in TL.
D. Java Sea (Ref. 1447), L in TL.
E. Langsa, Sumatra (Ref. 1467).
F. Banda Aceh, Sumatra (Ref. 1467).

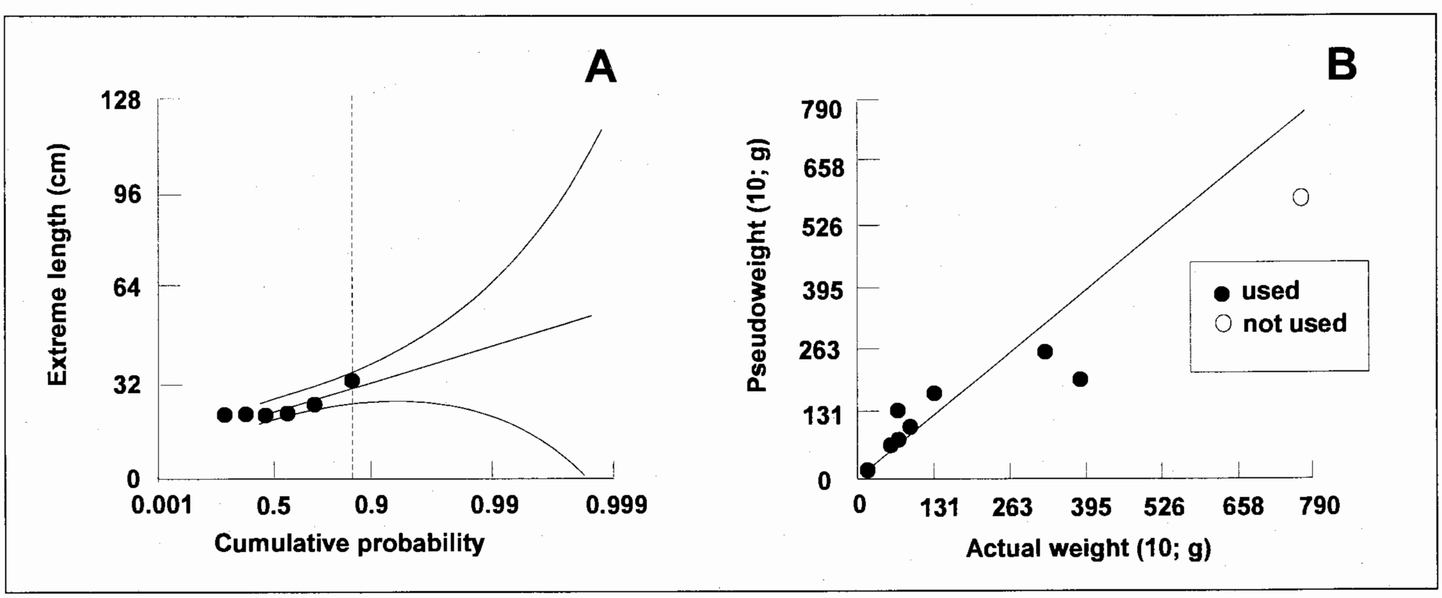

Fig. 34. (A) Extreme value plot for shortfin scad, *Decapterus macrosoma*, in Indonesia based on data from *R/Vs Dr. Fridtjof Nansen*, *Jurong* and *Bawal Putih 2*, showing maxima of 6 length-frequency samples, and estimate of L_{max3} = 28.95 ± 5.24 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 8 length-frequency samples of shortfin scad, *Decapterus macrosoma*, from Western Indonesia based on data from *R/Vs Dr. Fridtjof Nansen*, *Jurong* and *Bawal Putih 2* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 19). Open dot represents outlier, not used for analysis.
[Gambar 34. (A) Gambaran nilai ekstrim ikan layang deles, Decapterus macrosoma, *di Indonesia berdasarkan data dari kapal-kapal penelitian* Dr. Fridtjof Nansen, Jurong *dan* Bawal Putih 2, *menunjukkan nilai maksimum dari 6 contoh frekuensi-panjang, dan angka perkiraan* L_{max3} *= 28.95 ± 5.24 cm TL. (B) Berat prediksi terhadap berat berat observasi (dalam g berat basah) dari 8 contoh frekwensi-panjang ikan layang deles,* Decapterus macrosoma, *dari Indonesia bagian barat berdasarkan data kapal-kapal penelitian* Dr. Fridtjof Nansen, Jurong *dan* Bawal Putih 2 *sebagai output perangkat lunak ABee (lihat Box 1), dan yang memungkinkan suatu hubungan panjang-berat (lihat Tabel 19). Bulatan kosong mewakili suatu pengamatan yang tidak dipakai dalam analisis.]*

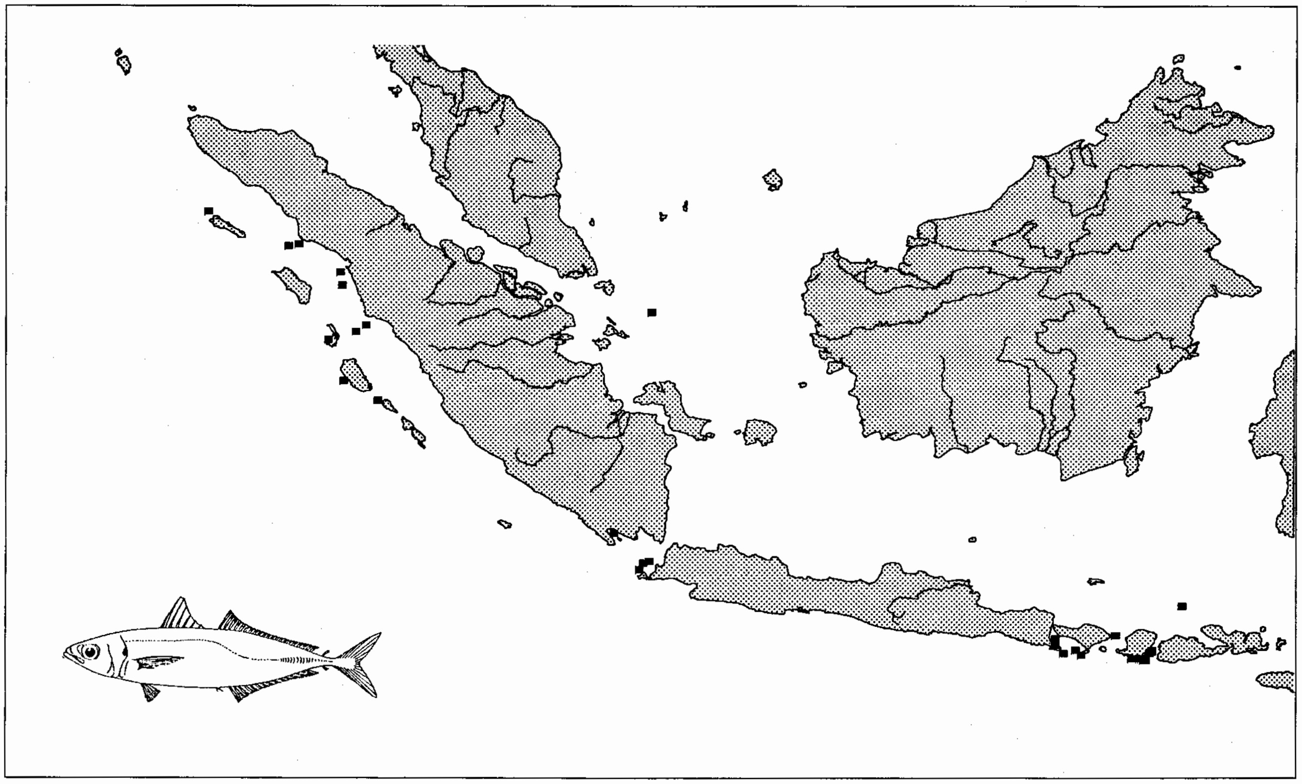

Fig. 35. Distribution of shortfin scad, *Decapterus macrosoma*, in Western Indonesia based on records of the surveys of *R/Vs Dr. Fridtjof Nansen, Jurong* and *Bawal Putih 2.*
[Gambar 35. Penyebaran ikan layang deles, Decapterus macrosoma, *di Indonesia bagian barat berdasarkan laporan survei kapal-kapal penelitian* Dr. Fridtjof Nansen, Jurong *dan* Bawal Putih 2.*]*

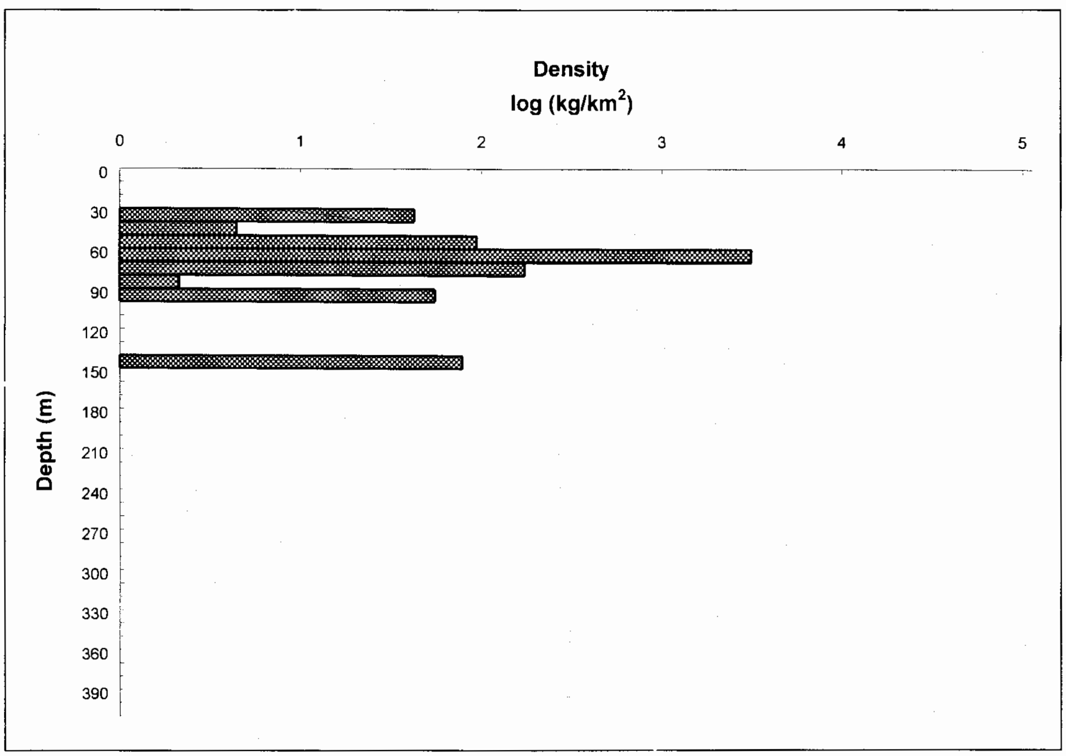

Fig. 36. Depth distribution of shortfin scad, *Decapterus macrosoma,* in Western Indonesia based on surveys of *R/V Jurong.*
[Gambar 36. Penyebaran kedalaman ikan layang deles, Decapterus macrosoma, *di Indonesia bagian barat berdasarkan survei kapal penelitian* Jurong.*]*

Decapterus russelli (Rüppell, 1830)

Indian scad (English); Lajang (Indonesian); Bengol, Korok, Ladjeng, Lajang (Java); Lajang (West Java, Jakarta); Kaban padara, Kaban patek, Ladjang (Madura); Rentjek bulus, Rentjek kaban, Rentjek padara, Rentjek patek (Madura).

Lateral line curved below soft dorsal and with 30-44 strong scutes; bluish green above, silvery below; caudal fin hyaline to yellowish; dorsal fins hyaline basally, light dusky distally. Opercle with small, black spot; opercular membrane with smooth margin. Snout longer than eye diameter; squarish lower posterior edge of maxilla; upper jaw with small teeth anteriorly; soft dorsal and anal fins relatively low, not falcate; pectoral fin subfalcate. Dorsal spines: 9-9; soft rays: 28-31; anal spines: 3-3; soft rays: 25-28. L_{max1} = 35 cm FL; L_{max2} = n.a.; L_{max3} = n.a. See Table 21 for length-weight relationship.

From East Africa via Southeast Asia and the Indonesian Archipelago (Fig. 37) to Japan and Australia (and possibly to New Caledonia).

Schooling in coastal waters and on open banks. Depth range: 40-275 m (Fig. 38). Feeds mainly on smaller planktonic invertebrates. Table 22 presents five sets of growth parameters from Indonesia.

References: 171, 312, 559, 761, 1263, 1314, 1384, 1385, 1454, 1455, 1632, 2021, 2334, 3131, 3197, 3287, 3555, 3556, 3807, 4537, 4546, 4591, 4838, 4883, 4931, 5213, 5284, 5337, 5339, 5406, 5417, 5418, 5432, 5433, 5434, 5440, 5441, 5443, 5444, 5446, 5525, 5730, 5736, 5756, 5885, 5970, 6026, 6365

Table 21. Length-weight (g/[TL; cm]) relationship of Indian scad, *Decapterus russelli,* in Indonesia.
[Tabel 21. Hubungan panjang-berat (g/[TL;cm]) ikan layang, Decapterus russelli, *di Indonesia.]*

Parameter	Estimates A	Estimates B
a	0.0112	0.0104
b	2.970	3.000
r^2	n.a.	0.980

A. Tegal (Ref. 5441), Length type unspecified.
B. Java Sea (Ref. 1385).

Table 22. Growth parameters of Indian scad, *Decapterus russelli.*
[Tabel 22. Parameter pertumbuhan ikan layang, Decapterus russelli.*]*

Parameter	A	B	C	D	E
L_∞ (cm)	26.0	26.6	27.0	27.0	28.4
K ($year^{-1}$)	0.90	0.95	1.15	1.18	0.90

A. Idi, Malacca Strait (Ref. 5432), L in FL.
B. Java Sea (Seribu Island) (Ref. 1314), L in TL.
C. Jakarta Bay (Seribu Island), L in TL, 1973 (Ref. 1314).
D. Jakarta Bay (Seribu Island), L in TL, 1975 (Ref. 1314).
E. Java Sea (Ref. 1385), L in FL.

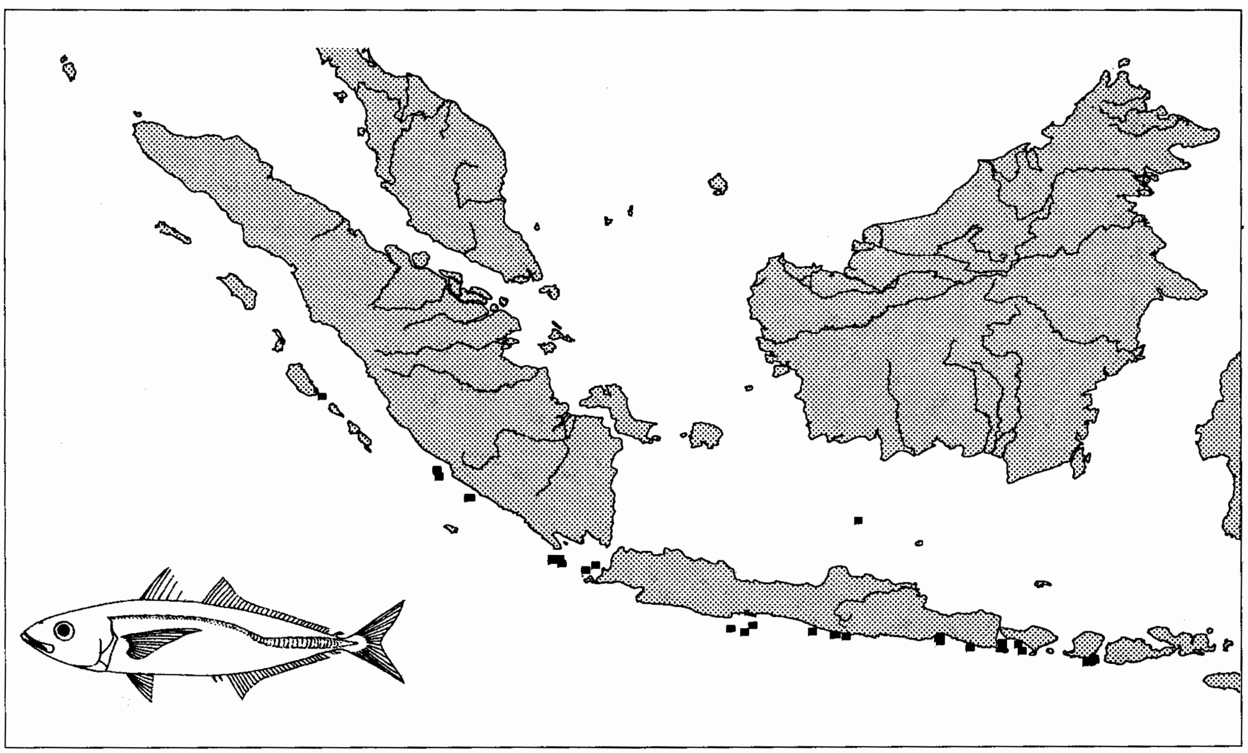

Fig. 37. Distribution of Indian scad, *Decapterus russelli*, in Western Indonesia based on records of the surveys of *R/Vs Jurong* and *Bawal Putih 2.*
[Gambar 37. Penyebaran ikan layang, Decapterus russelli, *di Indonesia bagian barat berdasarkan laporan survei kapal-kapal penelitian* Jurong *dan* Bawal Putih 2.*]*

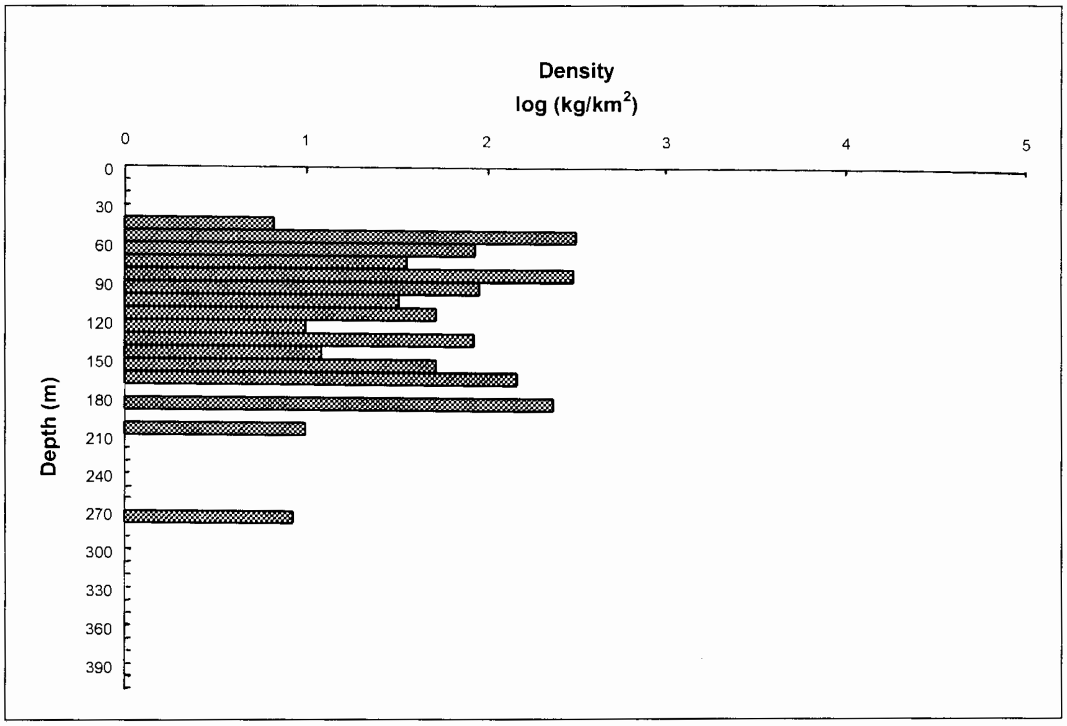

Fig. 38. Depth distribution of Indian scad, *Decapterus russelli,* in Western Indonesia, based on surveys of *R/V Jurong.*
[Gambar 38. Penyebaran kedalaman ikan layang, Decapterus russelli, *di Indonesia bagian barat berdasarkan survei kapal penelitian* Jurong.*]*

Parastromateus niger (Bloch, 1795)

Black pomfret (English); Bawal hitam (Indonesian); Gebel (Java); Bawal, Bawal hitam, Dorang, Dorang hitam (West Java, Jakarta); Dibas, Kandibas, Kapet, Kibas, Tjeplek (Madura); Bawal hitam (East Sumatra); Manriwasa leleng (South Sulawesi, Makasar); Peda-peda lotong (South Sulawesi, Bugis).

Deep-bodied and strongly compressed. Lateral line ends in weakly-developed scutes on the caudal peduncle. Pelvic fins lost in individuals over 9 cm. Color is brown above, silvery-white below. The anterior parts of the dorsal and anal fins bluish-gray, other fins yellowish. Dorsal spines: 2-6; soft rays: 41-46; anal spines: 2-2; soft rays: 35-40. L_{max1} = 75 cm; L_{max2} = n.a.; L_{max3} = 38.4 cm TL (Fig. 39A). See Fig. 39B and Table 23 for length-weight relationship.

From East Africa through the Indonesian Archipelago (Fig. 40) to southern Japan and Australia.

Forms large schools in coastal areas with muddy substrate. Depth range: 20-105 m (Fig. 41); near the bottom during daytime and near the water surface at night. Table 24 presents a set of growth parameters from Indonesia.

References: 171, 1314, 2334, 3287, 4789, 5213, 5284, 5736, 5756, 6365, 6567

Table 23. Length-weight (g/[TL;cm]) relationship of black pomfret, *Parastromateus niger,* in Indonesia.
[Tabel 23. Hubungan panjang-berat [g/(TL;cm)] ikan bawal hitam, Parastromateus niger*, di Indonesia.]*

Parameter	Estimate
a	0.0073
s.e.(a)	0.0063
b	3.3189
s.e.(b)	0.2676
r^2	0.8901

Table 24. Growth parameters of black pomfret, *Parastromateus niger.*
[Tabel 24. Parameter pertumbuhan ikan bawal hitam, Parastromateus niger.*]*

Parameter	A
L_∞ (TL, cm)	29.5
K (year^{-1})	0.68

A. Java Sea (Central Java) (Ref. 1314)

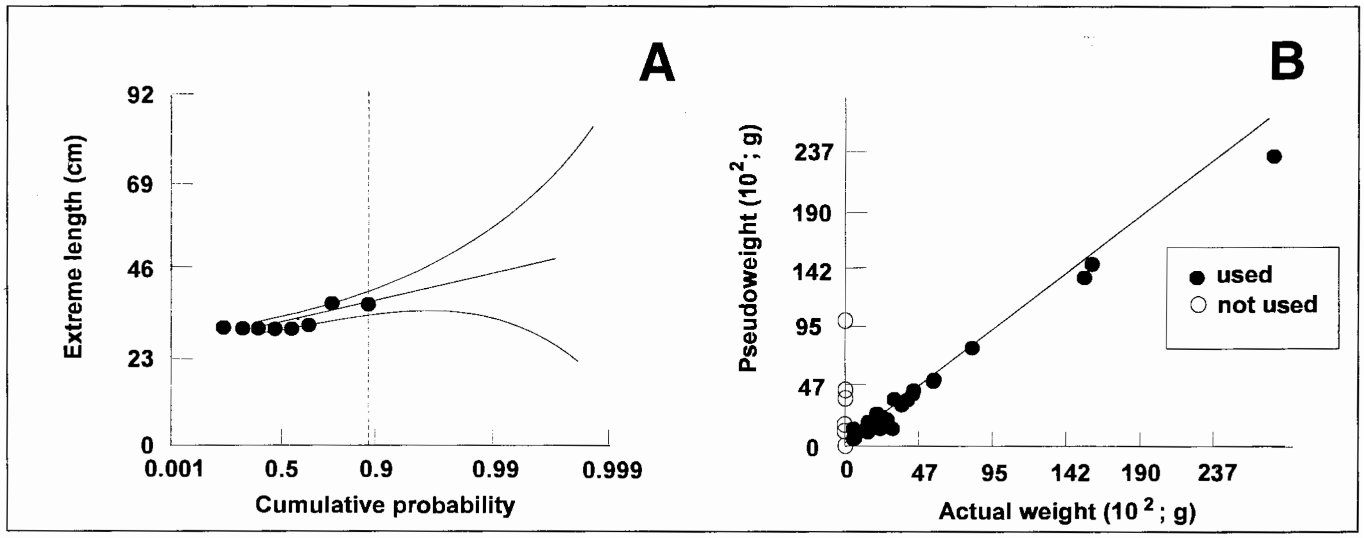

Fig. 39. (A) Extreme value plot for black pomfret, *Parastromateus niger*, in Indonesia based on data from *R/Vs Mutiara 4, Dr. Fridtjof Nansen, Bawal Putih 2* and *Jurong*, showing maxima of 8 length-frequency samples, and estimate of L_{max3} = 38.4 ± 3.3 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 26 length-frequency samples of black pomfret, *Parastromateus niger*, from Western Indonesia based on data from *R/Vs Mutiara 4, Dr. Fridtjof Nansen, Bawal Putih 2* and *Jurong* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 23). Open dots represent outliers, not used for analysis.
[Gambar 39. (A) Gambaran nilai ekstrim untuk ikan bawal hitam, Parastromateus niger, *di Indonesia berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Dr. Fridtjof Nansen, Bawal Putih 2 *dan* Jurong, *menunjukkan nilai maksimum untuk 8 contoh frekuensi-panjang, dan angka perkiraan* L_{max3} *= 38.4 ± 3.3 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 26 contoh frekuensi-panjang ikan bawal hitam,* Parastromateus niger, *dari Indonesia bagian barat berdasarkan data kapal-kapal penelitian* Mutiara 4, Dr. Fridtjof Nansen, Bawal Putih 2 *dan* Jurong *sebagai output perangkat lunak ABee (lihat Boks 1) yang memungkinkan estimasi hubungan panjang-berat (lihat Tabel 23). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

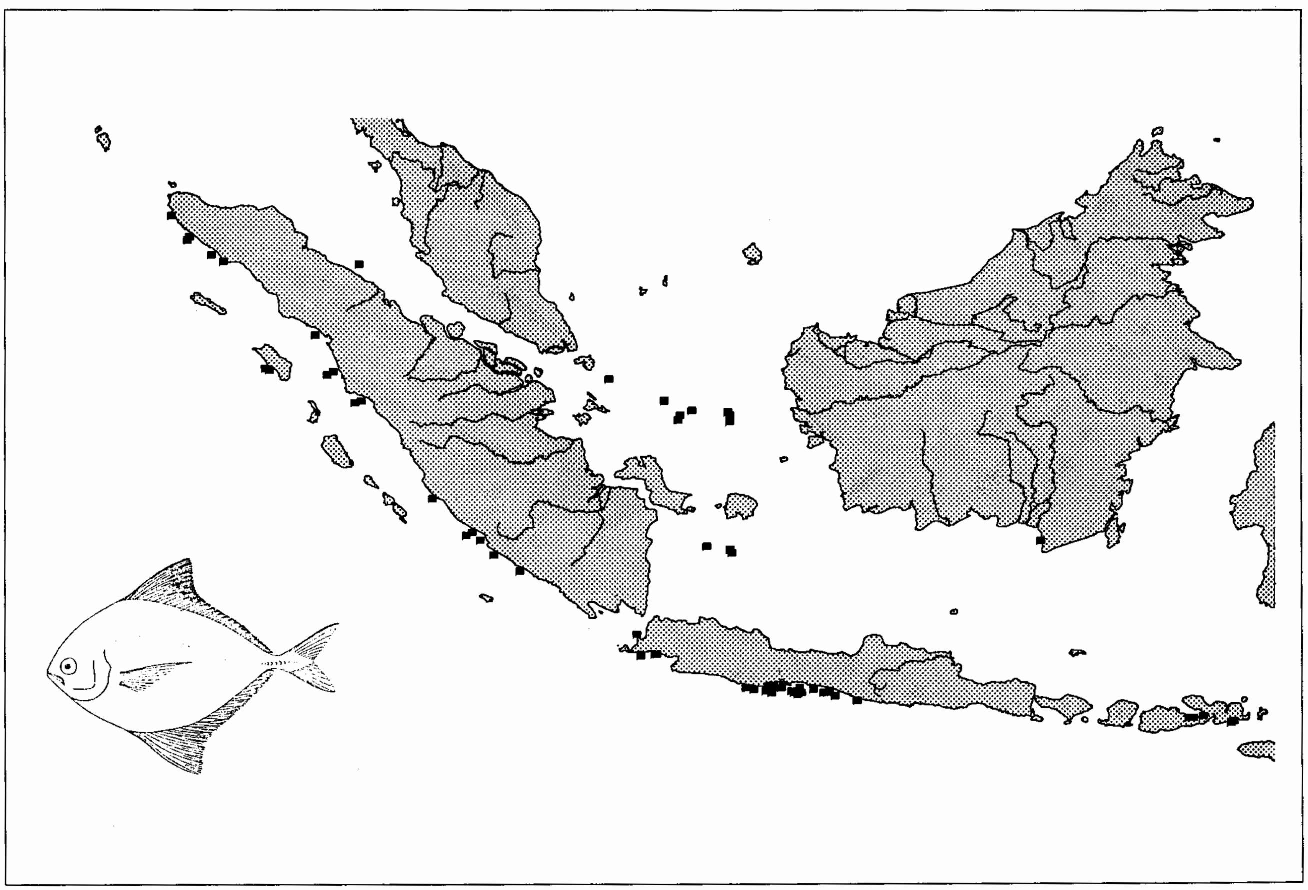

Fig. 40. Distribution of black pomfret, *Parastromateus niger*, in Western Indonesia based on records of the surveys of *R/Vs Dr. Fridtjof Nansen, Mutiara 4, Jurong* and Bawal *Putih 2.*
[Gambar 40. Penyebaran ikan bawal hitam, Parastromateus niger, *di Indonesia bagian barat berdasarkan laporan survei kapal-kapal penelitian* Dr. Fridtjof Nansen, Mutiara 4, Jurong *dan* Bawal Putih 2.*]*

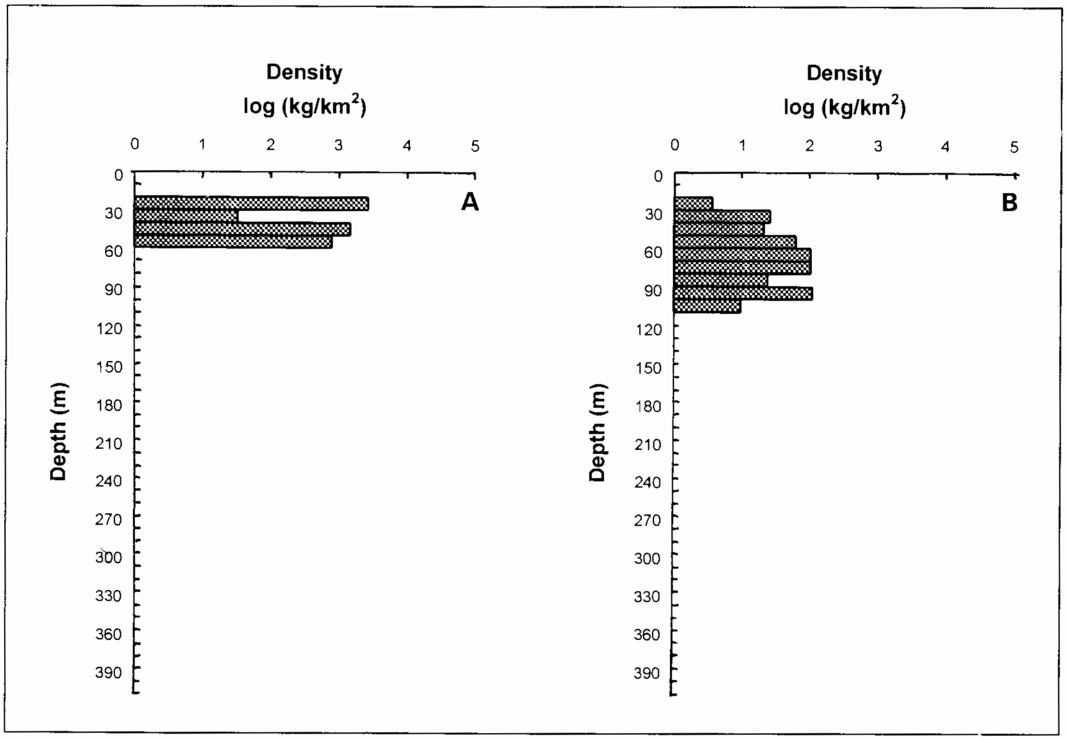

Fig. 41. Depth distribution of black pomfret, *Parastromateus niger,* in Western Indonesia based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen* and (B) *Jurong.*
[Gambar 41. Penyebaran kedalaman ikan bawal hitam, Parastromateus niger, *di Indonesia bagian barat berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen *dan (B)* Jurong.*]*

Selar crumenophthalmus (Bloch, 1793)

Bigeye scad (English); Bentong (Indonesian); Penteng, Pentong, Selar bentong (West Java, Jakarta); Bun bun, Tong gentong (Madura); Gintong (Central Sumatra).

Metallic blue to bluish green dorsally, shading to white ventrally; the lateral yellow stripe sometimes present. Lower margin of gill opening with a deep furrow, a large papilla immediately above it and a smaller one near upper edge. Operculum with black spot. Straight part of lateral line with 0-11 scales and 29-42 scutes. First two anal spines detached; pectoral fins falcate. Dorsal spines: 9-9; soft rays: 24-27; anal spines: 3-3; soft rays: 21-23. L_{max1} = 60 cm SL; L_{max2} = n.a.; L_{max3} = 26.7 cm FL (Fig. 42A). See Fig. 42B and Table 25 for length-weight relationship.

Circumtropical; Indo-Pacific: from southern Africa to Indonesia (Fig. 43); northeast to southern Japan and the Hawaiian Islands; south to New Caledonia and Rapa; east to Mexico to Peru and the Galapagos Islands, Western Atlantic: through the West Indies.

Forms small to large compact schools in inshore water and shallow reefs; mainly nocturnal; younger stages feed inshore on small shrimp and benthic invertebrates (including foraminiferans). The adults feed further offshore on zooplankton and fish larva, and range in depth from 10 to 170 m (Fig. 44). Table 26 presents two sets of growth parameters from Indonesia.

References: 171, 276, 1263, 1314, 1447, 1602, 2178, 2300, 2325, 2334, 2857, 3084, 3277, 3605, 3786, 3804, 3807, 4390, 4789, 4795, 4821, 4838, 4839, 4887, 4905, 5213, 5217, 5284, 5288, 5337, 5450, 5525, 5530, 5730, 5736, 5756, 5970, 6026, 6273, 6306, 6313, 6315, 6365, 6567, 6810

Table 25. Length-weight (g/[FL;cm]) relationship of bigeye scad, *Selar crumenophthalmus*, in Indonesia.
[Tabel 25. Hubungan panjang-berat (g/[FL;cm]) ikan selar bentong, Selar crumenophthalmus, *di Indonesia.]*

Parameter	Estimate
a	0.0176
s.e.(a)	0.0109
b	3.0039
s.e.(b)	0.2102
r^2	0.9737

Table 26. Growth parameters of bigeye scad, *Selar crumenophthalmus.*
[Tabel 26. Parameter pertumbuhan ikan selar bentong, Selar crumenophthalmus.*]*

Parameter	A	B
L_∞ (TL; cm)	25.9	26.9
K (year^{-1})	1.25	1.35

A. Java Sea (Pekalongan) (Ref. 1386)
B. Java Sea (Ref. 1447)

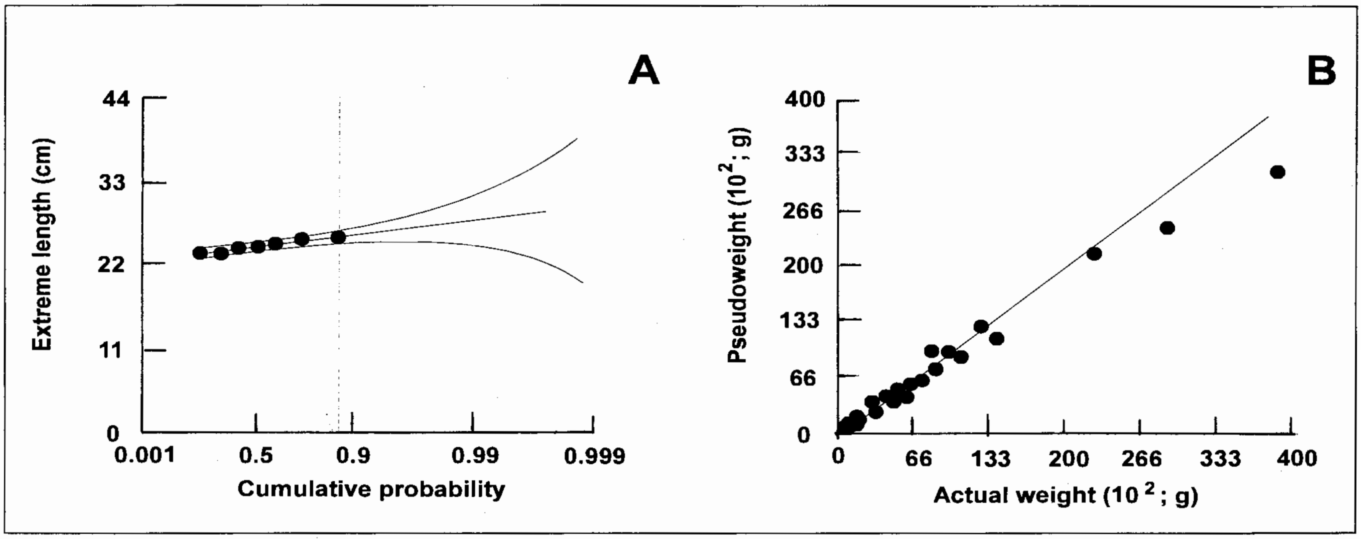

Fig. 42. (A) Extreme value plot for bigeye scad, *Selar crumenophthalmus*, in Indonesia based on data from *R/Vs Dr. Fridtjof Nansen, Jurong* and *Bawal Putih 2*, showing maxima of 7 length-frequency samples, and estimate of L_{max3} = 26.7 ± 0.86 cm FL. (B) Predicted *vs.* observed weights (in g wet weight) of 28 length-frequency samples of bigeye scad, *Selar crumenophthalmus*, from Western Indonesia based on data from *R/Vs Dr. Fridtjof Nansen, Jurong* and *Bawal Putih 2* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 25).

[Gambar 42. (A) Gambaran nilai ekstrim dari ikan selar bentong, Selar crumenophthalmus*, di Indonesia berdasarkan data dari kapal-kapal penelitian* Dr. Fridtjof Nansen, Jurong *dan* Bawal Putih 2 *menunjukkan nilai maksimum dari 7 contoh frekuensi-panjang, dan angka perkiraan* L_{max3} *= 26.7 ± 0.86 cm FL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 28 contoh frekuensi-panjang dari ikan selar bentong,* Selar crumenophthalmus, *dari Indonesia bagian barat berdasarkan data kapal-kapal penelitian* Dr. Fridtjof Nansen, Jurong *dan* Bawal Putih 2 *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 25).*

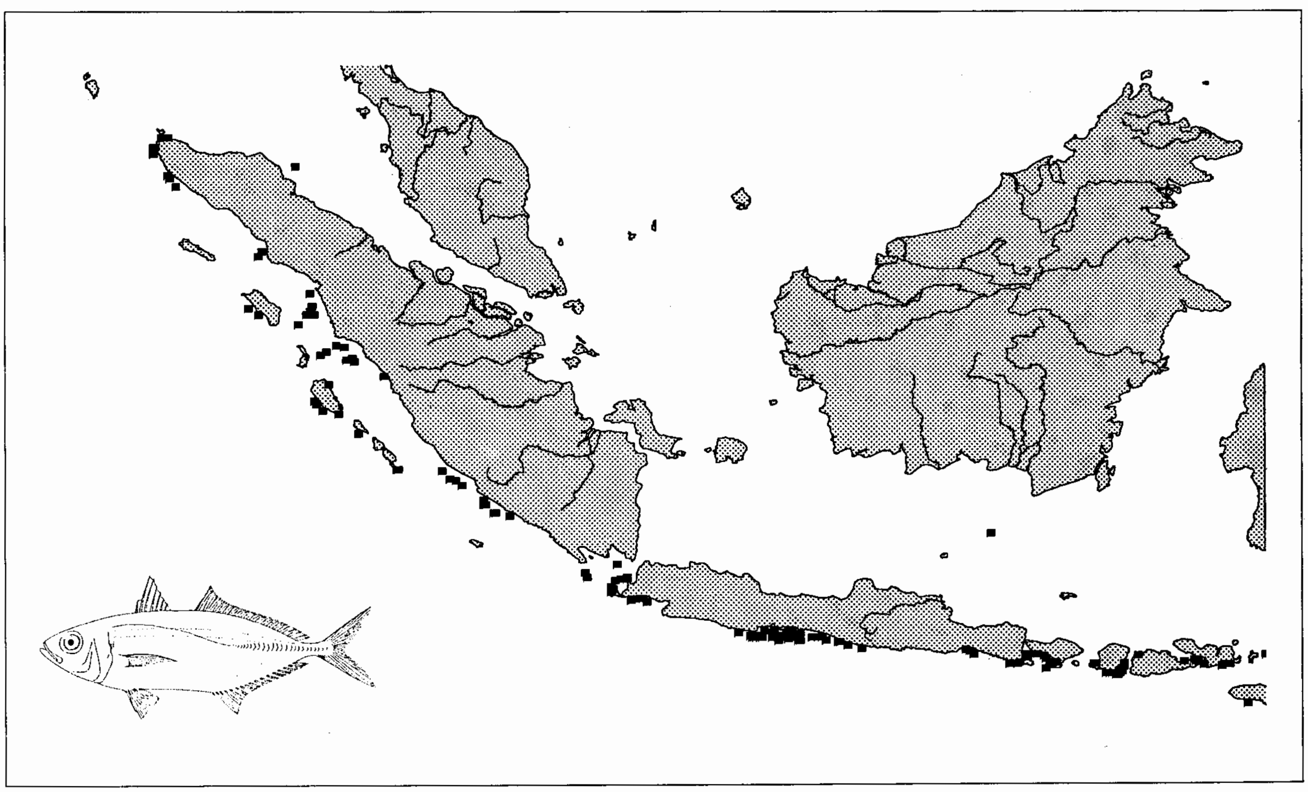

Fig. 43. Distribution of bigeye scad, *Selar crumenophthalmus*, in Western Indonesia based on records of the surveys of *R/Vs Dr. Fridtjof Nansen, Jurong* and *Bawal Putih 2.*

[Gambar 43. Penyebaran ikan selar bentong, Selar crumenophthalmus, *di Indonesia bagian barat berdasarkan laporan survei kapal-kapal penelitian* Dr. Fridtjof Nansen, Jurong *dan* Bawal Putih 2.*]*

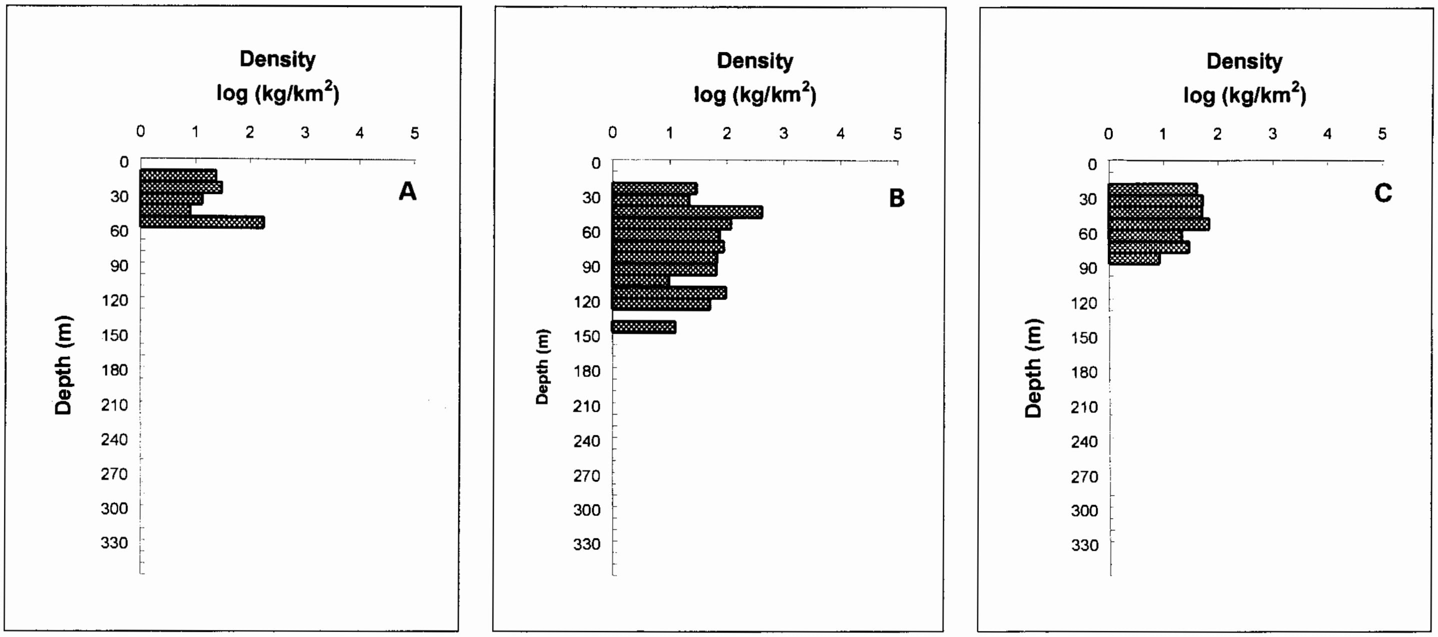

Fig. 44. Depth distribution of bigeye scad, *Selar crumenophthalmus*, in Western Indonesia based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen,* (B) *Jurong* and (C) *Bawal Putih 2.*
[Gambar 44. Penyebaran kedalaman ikan selar bentong, Selar crumenophthalmus, *di Indonesia bagian barat berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen, *(B)* Jurong *dan (C)* Bawal Putih 2.*]*

Pentaprion longimanus (Cantor, 1850)

Longfin mojarra (English); Lontong (Indonesian); Lontjong (Java); Hajam (West Java, Jakarta).

Body is slender, with weakly attached silvery scales. The spines of the dorsal and anal fins longer than the rays; the pectoral fins long and pointed, reaching beyond the anal fin spines; the anal fin is long; the caudal fin lobes rounded. Dorsal spines: 9-10; soft rays: 14-15; anal spines: 5-6; soft rays: 12-13. L_{max1} = 15 cm; L_{max2} = n.a.; L_{max3} = 15.5 cm TL (Fig. 45A). See Fig. 45B and Table 27 for length-weight relationship.

Indian Ocean: from the western and southern coasts of India and off Sri Lanka to Indonesia. Western Pacific: Indonesia (Fig. 46) to the Philippines and the Ryukyu Islands, and south to the northern part of Australia.

Forms large schools in coastal waters. Depth range: 20-220 m (Fig. 47). Feeds on small benthic animals. Table 28 presents six sets of growth parameters from Indonesia.

References: 393, 559, 1263, 1314, 1381, 1392, 1435, 1449, 1452, 1486, 1966, 2029, 2178, 2857, 2872, 2926, 3131, 3399, 3409, 3807, 4672, 4749, 5381, 5756, 6365, 6567

Table 27. Length-weight (g/[TL;cm]) relationship of longfin mojarra, *Pentaprion longimanus*, in Indonesia. *[Tabel 27. Hubungan panjang-berat (g/[TL;cm]) ikan loncong,* Pentaprion longimanus, *di Indonesia.]*

Parameter	Estimate
a	0.0169
s.e.(a)	0.0080
b	2.9173
s.e.(b)	0.1949
r^2	0.9725

Table 28. Growth parameters of longfin mojarra, *Pentaprion longimanus*. *[Tabel 28. Parameter pertumbuhan ikan loncong,* Pentaprion longimanus.*]*

Parameter	A	B	C	D	E	F
L_∞ (cm)	13.4	13.5	13.7	14.2	15.6	15.6
K (year^{-1})	1.77	1.10	1.12	1.80	0.80	0.94

A. Java Sea (Ref. 1452)
B. Java Sea (Semarang) (Ref. 1314), L in TL
C. Java Sea (Ref. 1452)
D. Java Sea (Ref. 1452)
E. Java Sea (Ref. 1452)
F. Java Sea (southern) (Ref. 1381), L in TL

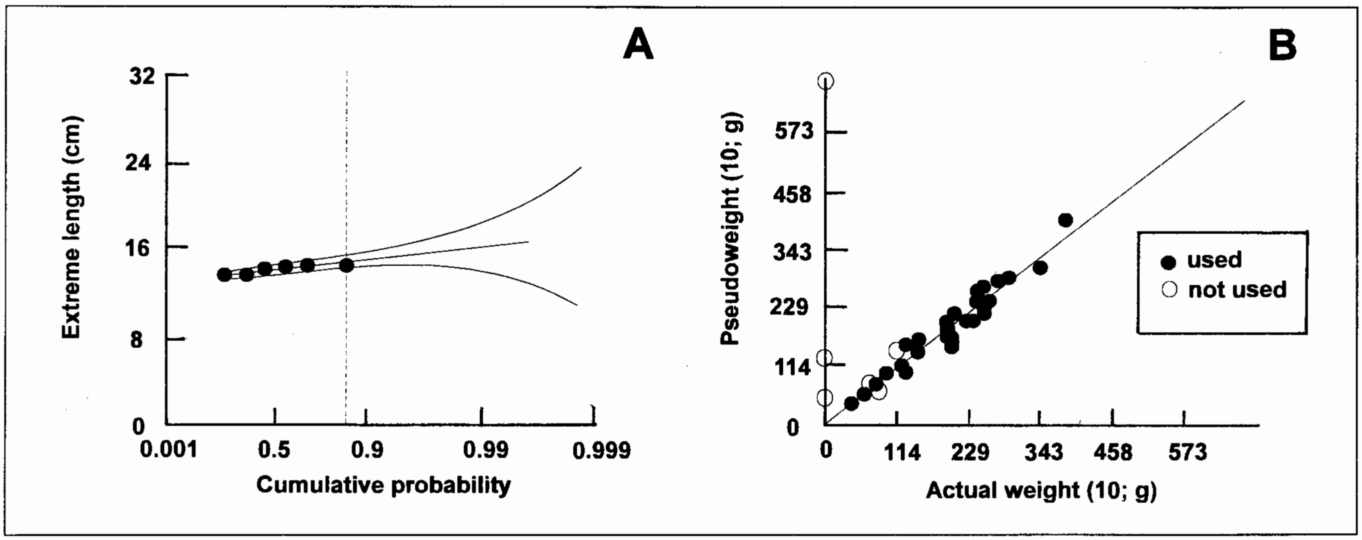

Fig. 45. (A) Extreme value plot for longfin mojarra, *Pentaprion longimanus*, in Indonesia based on data from *R/Vs Mutiara 4* and *Dr. Fridtjof Nansen* showing maxima of 6 length-frequency samples, and estimate of L_{max3} = 15.5 ± 0.54 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 39 length-frequency samples of longfin mojarra, *Pentaprion longimanus*, from Western Indonesia based on data from *R/Vs Mutiara 4, Jurong* and *Dr. Fridtjof Nansen* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 27). Open dots represent outliers, not used for analysis.

[Gambar 45. (A) Gambaran nilai ekstrim dari ikan loncong, Pentaprion longimanus, *di Indonesia berdasarkan data kapal-kapal penelitian* Mutiara 4 *dan* Dr. Fridtjof Nansen *menunjukkan nilai maksimum dari 6 contoh frekuensi-panjang, dan angka perkiraan* L_{max3} *= 15.5 ± 0.54 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 39 contoh frekuensi-panjang dari ikan loncong,* Pentaprion longimanus, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Jurong *dan* Dr. Fridtjof Nansen *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 27). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

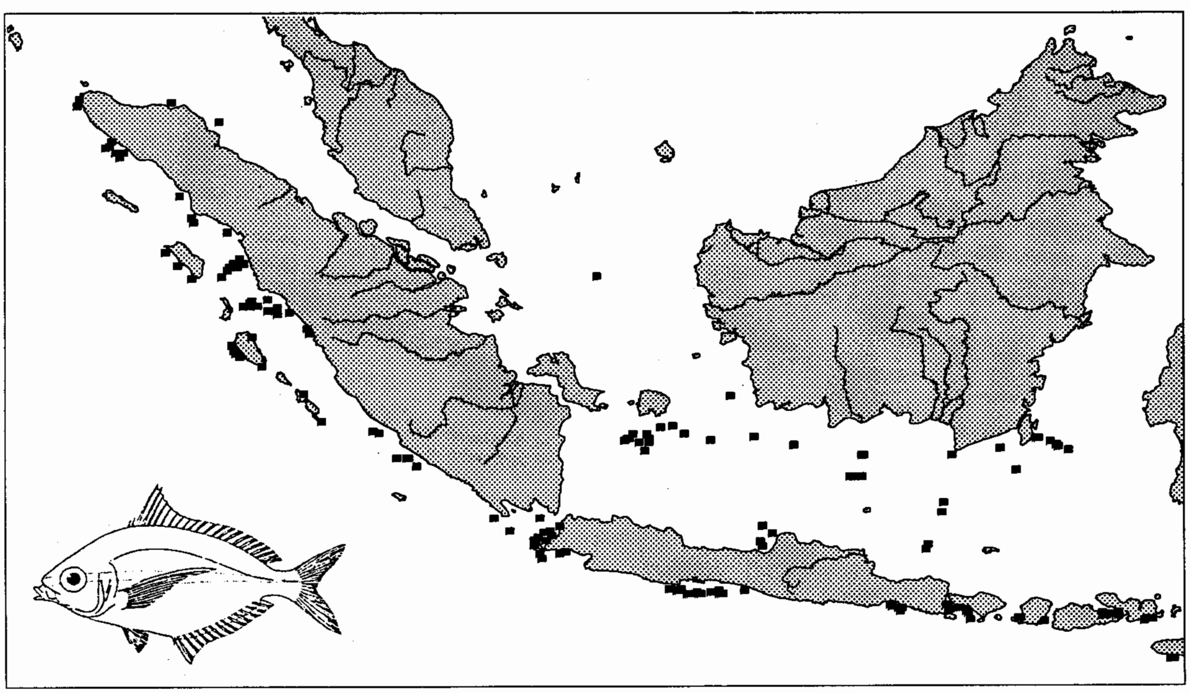

Fig. 46. Distribution of longfin mojarra, *Pentaprion longimanus*, in Western Indonesia based on records of the surveys of *R/Vs Dr. Fridtjof Nansen, Mutiara 4, Jurong* and *Bawal Putih 2*.

[Gambar 46. Penyebaran ikan loncong, Pentaprion longimanus, *di Indonesia bagian barat berdasarkan laporan survei kapal-kapal penelitian* Dr. Fridtjof Nansen, Mutiara 4, Jurong *dan* Bawal Putih 2.*]*

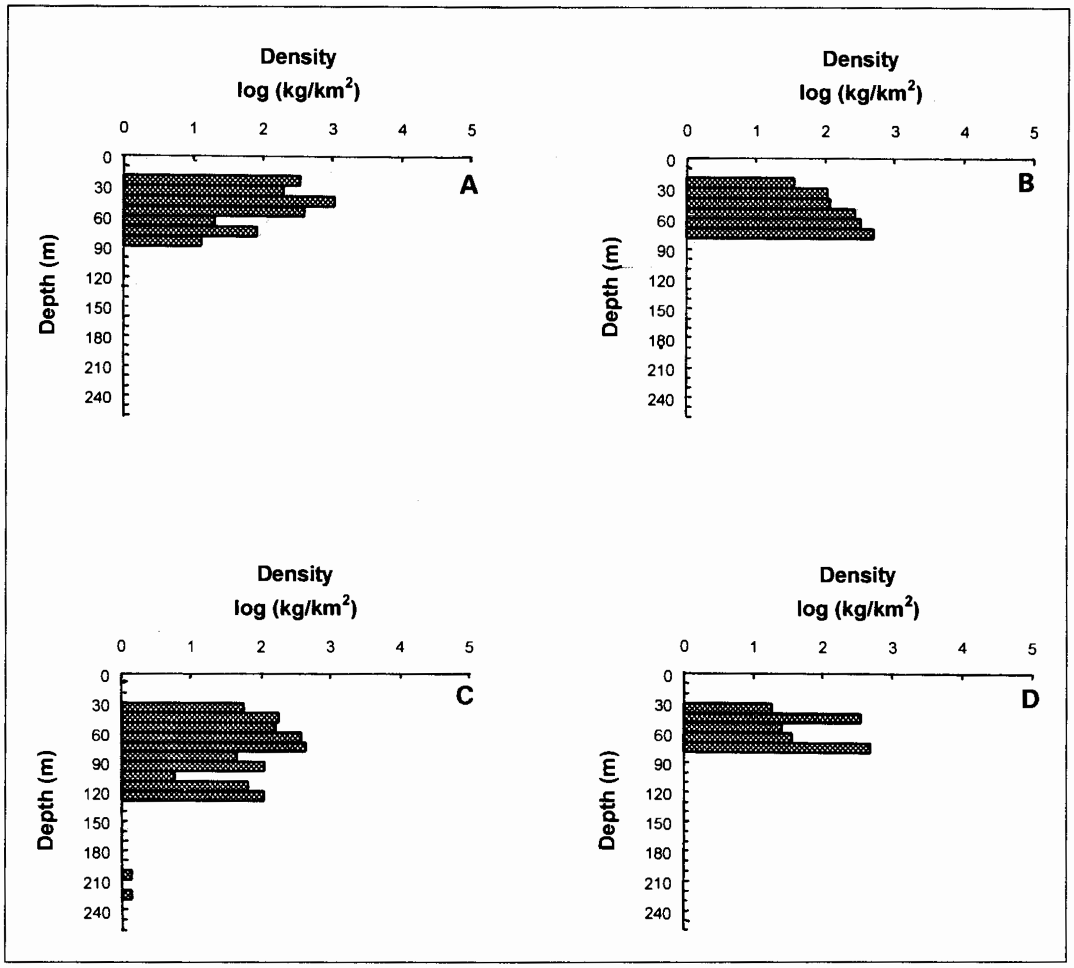

Fig. 47. Depth distribution of longfin mojarra, *Pentaprion longimanus,* in Western Indonesia based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen,* (B) *Mutiara 4,* (C) *Jurong* and (D) *Bawal Putih 2.*
[Gambar 47. Penyebaran kedalaman ikan loncong, Pentaprion longimanus, *di Indonesia bagian barat berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen, *(B)* Mutiara 4, *(C)* Jurong *dan (D)* Bawal Putih 2.*]*

Diagramma pictum (Thunberg, 1792)

Painted sweetlips (English); Gadjih (Indonesian); Katji (Java); Katji-katji (Java); Domul (West Java, Jakarta); Gadji (Java, Jakarta); Gadji-gadji (Java, Jakarta); Ikan kadji (West Java, Jakarta); Kadji (West Java, Jakarta); Besiko (Riouw); Domul (Riouw); Radja bau (Ceram, Wahai, Ambon, Luhu, Saparua, Haria, Geser).

Body typically perciform. Flesh in maxilla thick. Usually cardiform jaw teeth. Vomer generally toothless. Usually with enlarged chin pore. Branchiostegal rays: 7. Dorsal spines: 9-10; soft rays: 21-26; anal spines: 3-3; soft rays: 7-8. L_{max1} = 100 cm FL; L_{max2} = n.a.; L_{max3} = 84.2 cm TL (Fig. 48A). See Fig. 48B and Table 29 for length-weight relationship.

Indo-West Pacific: East Africa and Red Sea, Indonesia to New Caledonia, north to Japan.

Occurs in shallow coastal areas and coral reefs. Depth range: 20-170 m. (Fig. 50). Juveniles usually occur in seaweed beds, and large adults in small schools or solitary around coral. Carnivore; feeds on benthic invertebrates and fishes.

References: 280, 559, 1498, 1602, 1830, 2112, 2290, 2334, 2682, 2799, 2871, 2872, 3111, 3131, 3412, 3626, 3670, 3678, 4517, 5213, 5450, 5525, 5736, 5970, 5978, 6026, 6065, 6066, 6067, 6068, 6365, 6567, 6956, 9070, 9137

Table 29. Length-weight (g/[TL;cm]) relationship of painted sweetlips, *Diagramma pictum,* in Indonesia.
[Tabel 29. Hubungan panjang-berat (g/[TL;cm]) ikan kaji, Diagramma pictum, *di Indonesia.]*

Parameter	Estimate
a	0.0077
s.e.(a)	0.0058
b	3.1314
s.e.(b)	0.1783
r^2	0.9867

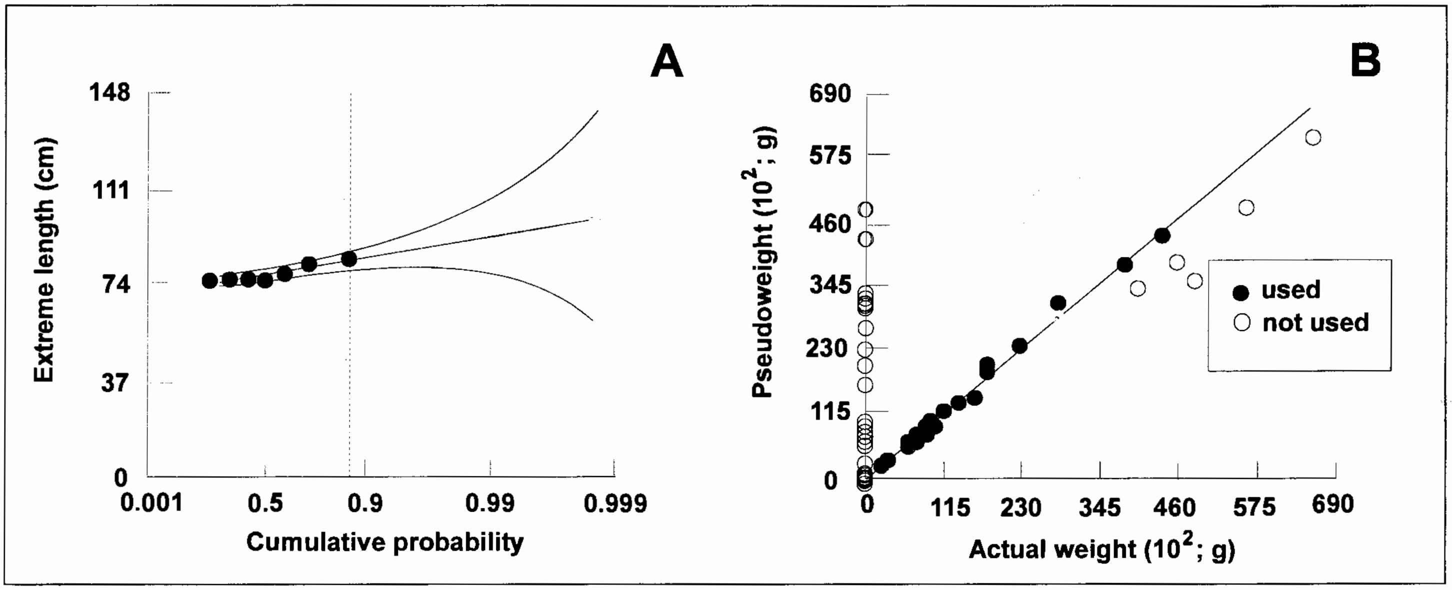

Fig. 48. (A) Extreme value plot for painted sweetlips, *Diagramma pictum*, in Indonesia based on data from *R/Vs Mutiara 4* and *Jurong* showing maxima of 7 length-frequency samples, and estimate of L_{max3} = 84.2 ± 3.6 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 21 length-frequency samples of painted sweetlips, *Diagramma pictum*, from Western Indonesia based on data from *R/Vs Mutiara 4, Jurong* and *Bawal Putih 2* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 29). Open dots represent outliers, not used for analysis.
[Gambar 48. (A) Penggambaran nilai ekstrim untuk ikan kaji, Diagramma pictum, *di Indonesia berdasarkan data dari kapal-kapal penelitian* Mutiara 4 *dan* Jurong *menunjukkan nilai maksimum dari 7 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 84.2 ± 3.6 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 21 contoh frekuensi panjang ikan kaji,* Diagramma pictum, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Jurong *dan* Bawal Putih 2 *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 29). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

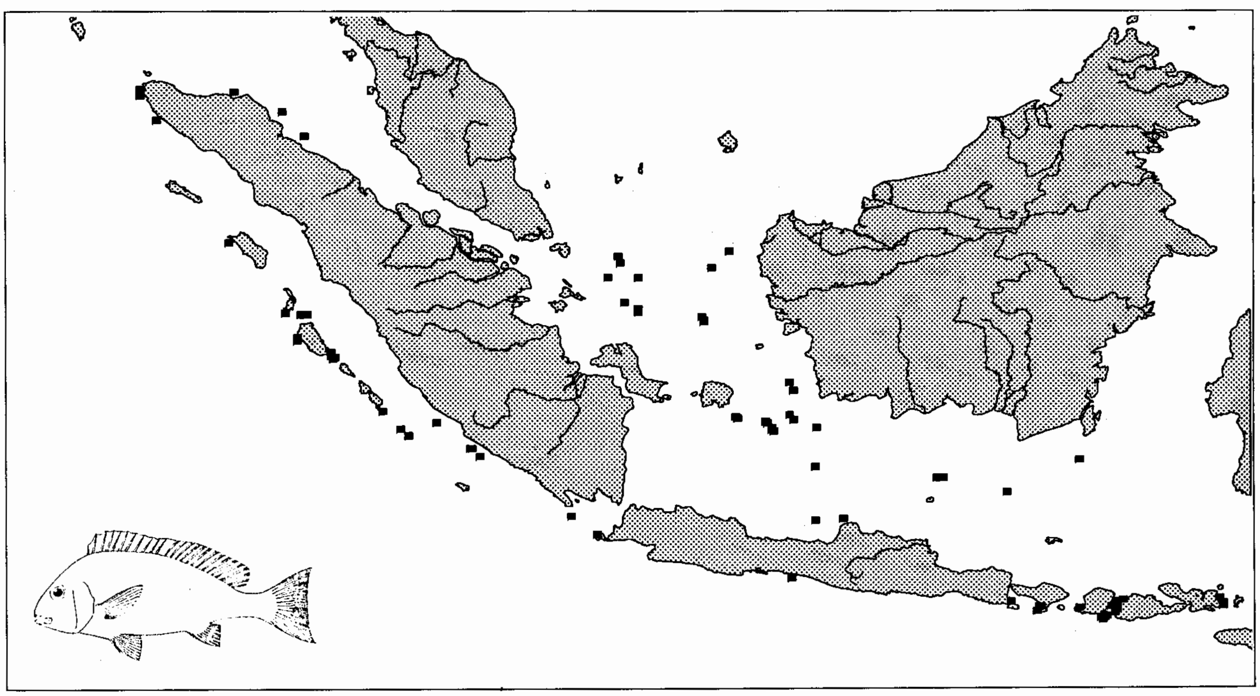

Fig. 49. Distribution of painted sweetlips, *Diagramma pictum*, based on records of the surveys of *R/Vs Dr. Fridtjof Nansen, Mutiara 4, Jurong* and *Bawal Putih 2.*
[Gambar 49. Penyebaran ikan kaji, Diagramma pictum, *berdasarkan laporan survei kapal-kapal penelitian* Dr. Fridtjof Nansen, Mutiara 4, Jurong *dan* Bawal Putih 2.*]*

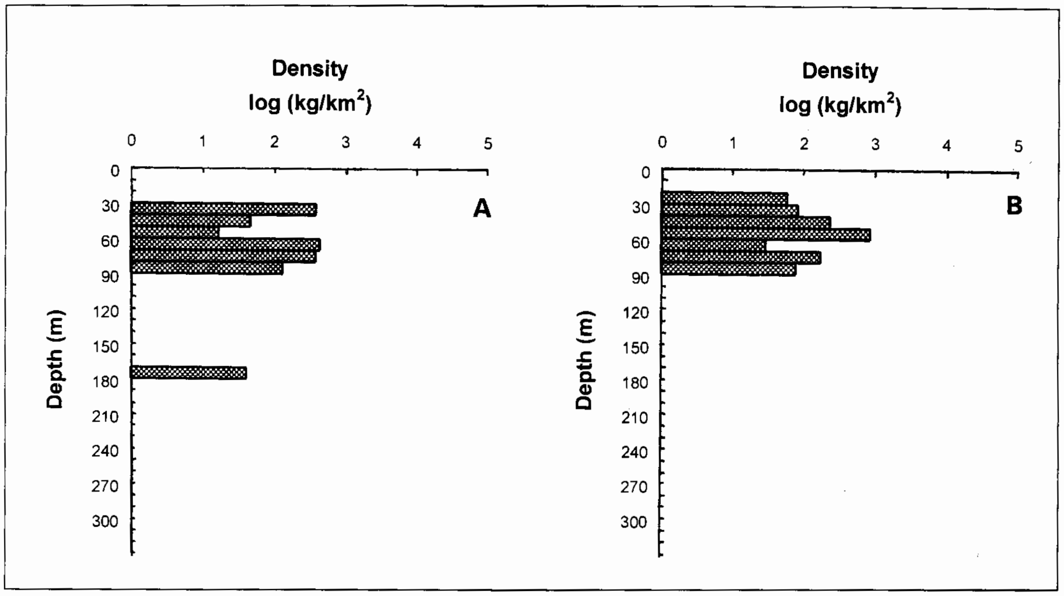

Fig. 50. Depth distribution of painted sweetlips, *Diagramma pictum*, based on surveys of *R/Vs* (A) *Jurong* and (B) *Bawal Putih 2.*
[Gambar 50. Penyebaran kedalaman ikan kaji, Diagramma pictum, *berdasarkan survei kapal-kapal penelitian (A)* Jurong *dan (B)* Bawal Putih 2.*]*

Pomadasys argenteus (Forsskål, 1775)

Silver grunt (English); Da-tanda (Indonesian); Krokot (Java); Gerot-gerot, Kerot-kerot, Krot, Krot-krot (West Java, Jakarta); Da-tanda, Mengantih, Towoito (Madura); Ronga (South Sulawesi, Makassar); Garut (West Borneo).

Body ovate; head profile almost straight. Mouth small; lips not thickened; two pores and a central groove under the chin. No antrorse spine before the dorsal fin origin; notch between the spinous and soft rayed portion of the dorsal fin shallow. Color is generally silver-mauve to fawn above, white below. Small specimens with numerous spots aligned horizontally or fused into horizontal lines; large specimens plain or with scattered charcoal scale spots on back and upper sides; the snout is dark brown; the upper operculum charcoal or purplish. Dorsal spines: 12-12; soft rays: 13-14; anal spines: 3-3; soft rays: 7-7. L_{max1} = 66 cm TL; L_{max2} = n.a.; L_{max3} = 60.4 cm TL (Fig. 51A). See Fig. 51B and Table 30 for length-weight relationship.

From the Red Sea to Indonesia (Fig. 52) and the Philippines (but without record from the Persian Gulf) and southern to northern Australia. Also reported from New Caledonia.

Found in coastal waters. Depth range: 15-115 m (Fig. 53). Mainly carnivore, feeds on benthic animals. Table 31 presents a set of growth parameters from Indonesia.

References: 312, 1115, 1116, 1139, 1314, 3412, 3624, 3627, 3642, 3670, 3678, 4606, 4959, 5284, 5450, 5525, 5736, 5756, 6026, 6365

Table 30. Length-weight (g/[TL;cm]) relationship of silver grunt, *Pomadasys argenteus*, in Indonesia.
[Table 30. Hubungan panjang-berat (g/[TL;cm]) ikan da-tanda, Pomadasys argenteus, *di Indonesia.]*

Parameter	Estimate
a	0.0267
s.e.(a)	0.0157
b	2.8551
s.e.(b)	0.1545
r^2	0.9758

Table 31. Growth parameter of silver grunt, *Pomadasys argenteus.*
[Tabel 31. Parameter pertumbuhan ikan da-tanda, Pomadasys argenteus.*]*

Parameter	A
L_∞ (TL; cm)	54
K (year^{-1})	0.5

A. Java Sea (Tanjung Selatan, South Kalimantan) (Ref. 1314)

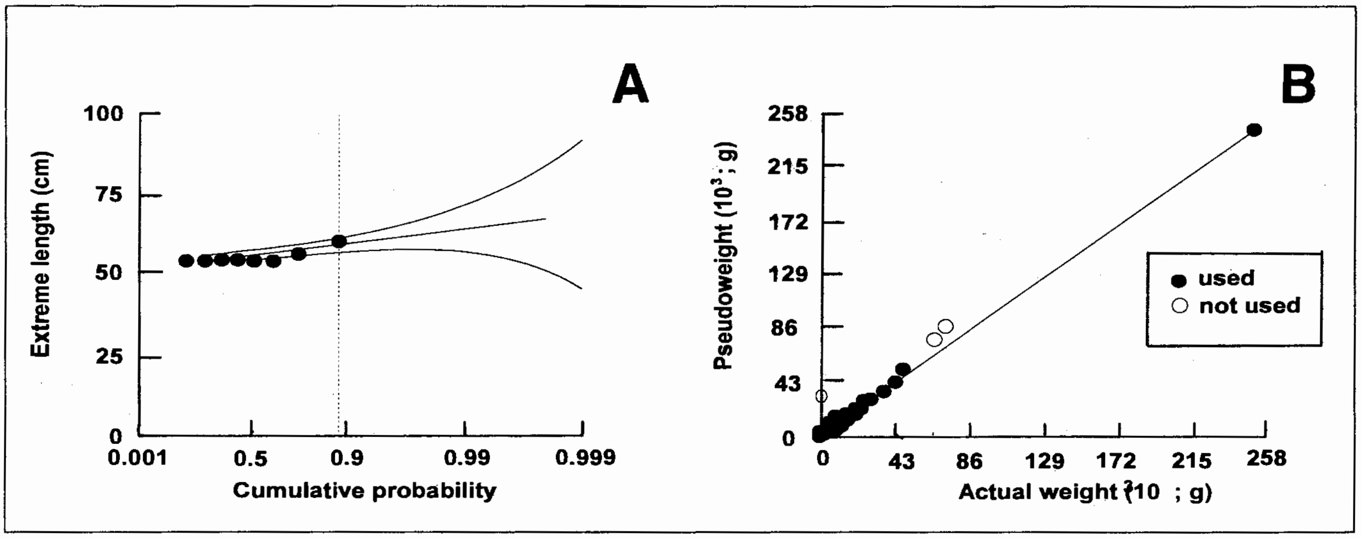

Fig. 51. (A) Extreme value plot for silver grunt, *Pomadasys argenteus*, in Indonesia based on data from *R/V Jurong* showing maxima of 8 length-frequency samples, and estimate of L_{max3} = 60.4 ± 2.2 cm TL. (B) Predicted vs. observed weights (in g wet weight) of 42 length-frequency samples of silver grunt, *Pomadasys argenteus*, from Western Indonesia based on data from *R/Vs Mutiara 4*, *Jurong* and *Bawal Putih 2* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 30). Open dots represent outliers, not used for analysis.

[Gambar 51. (A) Gambaran nilai ekstrim ikan da-tanda, Pomadasys argenteus, *di Indonesia berdasarkan data dari kapal penelitian Jurong menunjukkan nilai maksimum dari 8 contoh frekuensi-panjang, dan nilai perkiraan* L_{max3} *= 60.4 ± 2.2 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 42 contoh frekuensi-panjang ikan da tanda,* Pomadasys argenteus, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Jurong *dan* Bawal Putih 2 *sebagai output perangkat lunak ABee (lihat Boks 1), yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 30). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

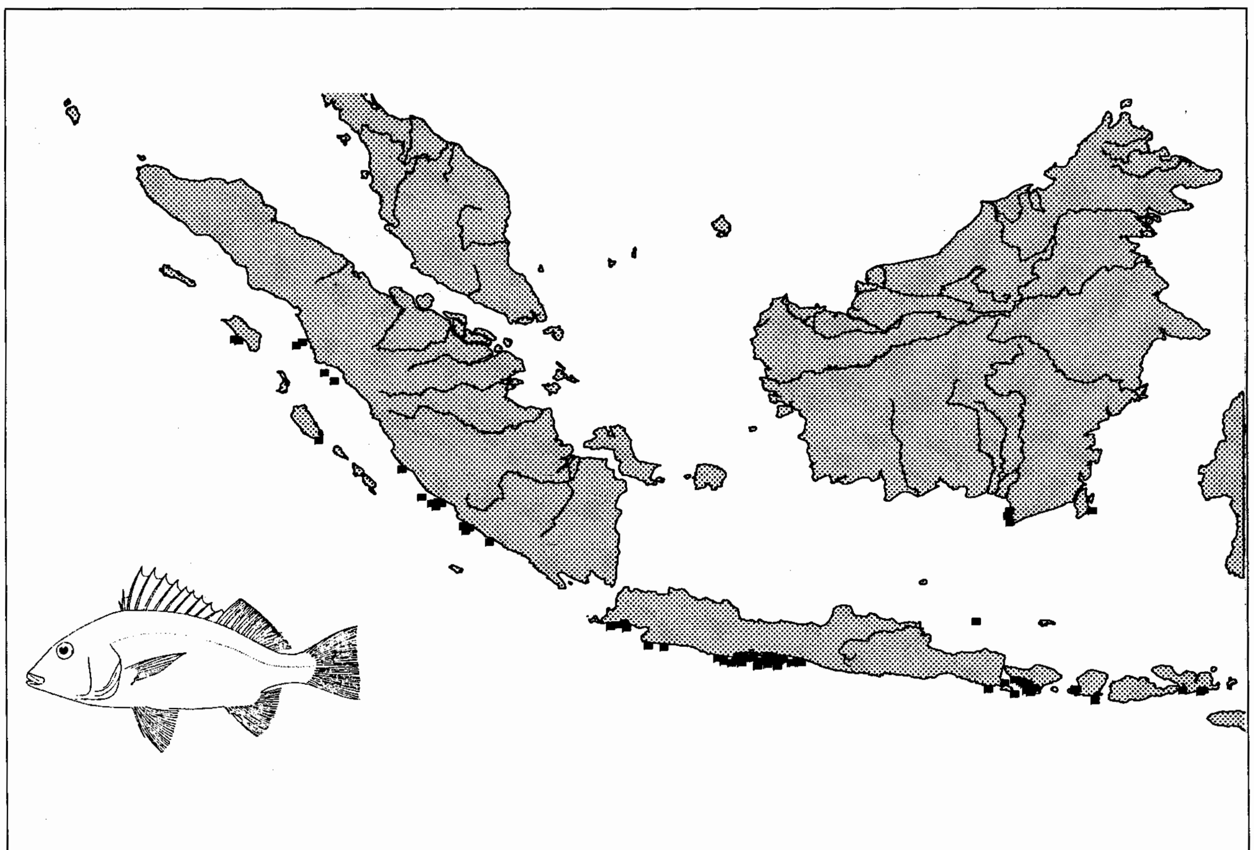

Fig. 52. Distribution of silver grunt, *Pomadasys argenteus,* in Western Indonesia based on records of the surveys of *R/Vs Mutiara 4, Jurong* and *Bawal Putih 2.*

[Gambar 52. Penyebaran ikan da-tanda, Pomadasys argenteus, *di Indonesia bagian barat berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Jurong *dan* Bawal Putih 2.*]*

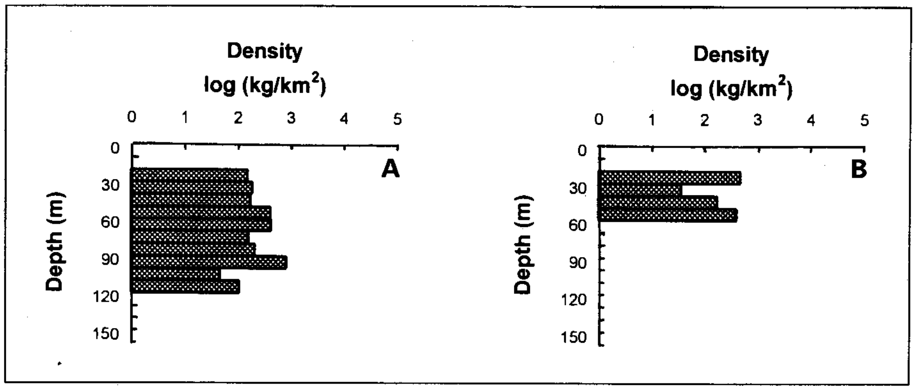

Fig. 53. Depth distribution of silver grunt, *Pomadasys argenteus*, in Western Indonesia based on surveys of *R/Vs* (A) *Jurong* and (B) *Bawal Putih 2*.
[Gambar 53. Penyebaran kedalaman ikan da-tanda, Pomadasys argenteus, *di Indonesia bagian barat berdasarkan survei kapal-kapal penelitian (A)* Jurong *dan (B)* Bawal Putih 2.*]*

Pomadasys maculatus (Bloch, 1797)

Saddle grunt (English); Gerot-gerot (Indonesian); Gerot-gerot, Ikan krot, Kerot-kerot, Krot-krot (West Java, Jakarta).

Small-sized fish of moderately deep body. Isthmus narrow, forming a groove. Chin with two pairs of small pores. This species is characterized by several dark large elongate blotches on the upper back, one forming a saddle on the nape. Dorsal spines: 12-12; soft rays: 13-14; anal spines: 3-3; soft rays: 7-7. L_{max1} = 59.3 cm FL; L_{max2} = n.a.; L_{max3} = 57.5 cm FL (Fig. 54A). See Fig. 54B and Table 32 for length-weight relationship.

Indo-West Pacific: from the east coast of Africa and Madagascar, to Southeast Asia, via the Indonesian Archipelago (Fig. 55) and, thence northeast to China and southeast to Australia.

Found in coastal waters over sand near reefs; depth range: 20-110 m (Fig. 56). Feeds on crustaceans and fish.

References: 280, 393, 1498, 2112, 2135, 2857, 2871, 2872, 3225, 3626, 4749, 5213, 5450, 5736, 5756, 6567

Table 32. Length-weight (g/[FL;cm]) relationship of saddle grunt, *Pomadasys maculatus*, in Indonesia.
[Tabel 32. Hubungan panjang-berat (g/[FL;cm]) dari ikan gerot-gerot, Pomadasys maculatus, *di Indonesia.]*

Parameter	Estimate
a	0.0799
s.e.(a)	0.0307
b	2.5693
s.e.(b)	0.1085
r^2	0.9856

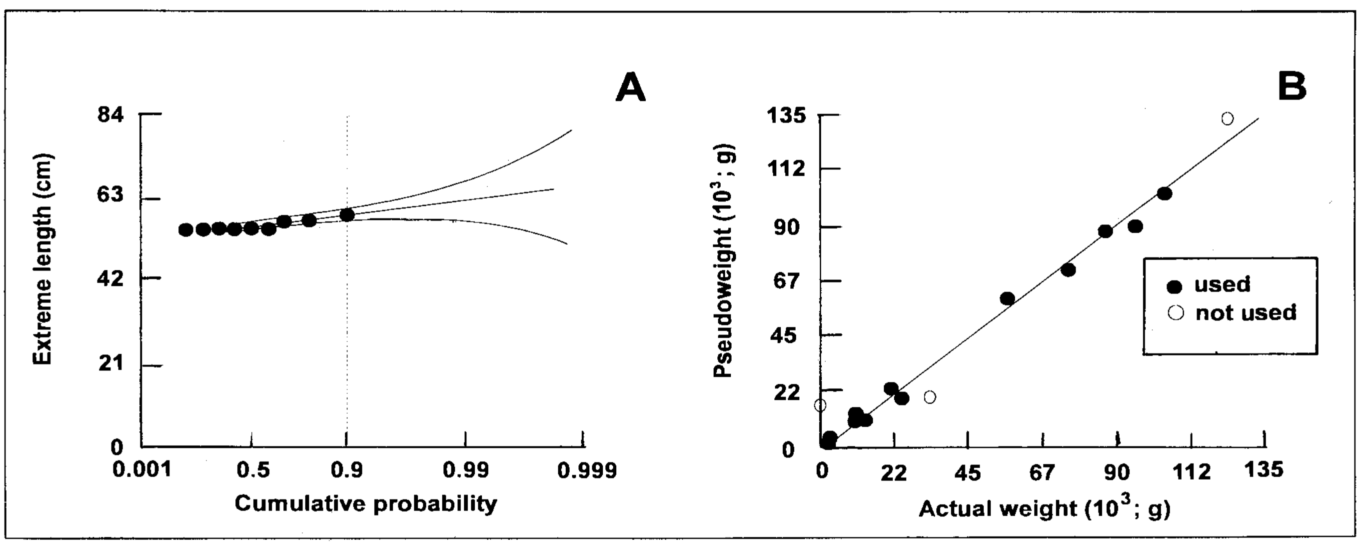

Fig. 54. (A) Extreme value plot for saddle grunt, *Pomadasys maculatus*, in Indonesia based on data from *R/Vs Jurong* and *Bawal Putih 2* showing maxima of 9 length-frequency samples, and estimate of L_{max3} = 57.5 $\pm$ 1.5 cm FL. (B) Predicted *vs.* observed weights (in g wet weight) of 13 length-frequency samples of silver grunt, *Pomadasys maculatus*, from Western Indonesia based on data from *R/Vs Mutiara 4, Dr. Fridtjof Nansen*, *Jurong* and *Bawal Putih 2* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 32). Open dots represent outliers, not used for analysis.
[Gambar 54. (A) Gambaran nilai ekstrim ikan gerot-gerot, Pomadasys maculatus, *di Indonesia berdasarkan data kapal-kapal penelitian* Jurong *dan* Bawal Putih 2 *menunjukkan nilai maksimum dari 9 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 57.5 $\pm$ 1.5 cm FL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 13 contoh frekuensi-panjang ikan gerot-gerot,* Pomadasys maculatus, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Dr. Fridtjof Nansen, Jurong *dan* Bawal Putih 2 *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 32). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

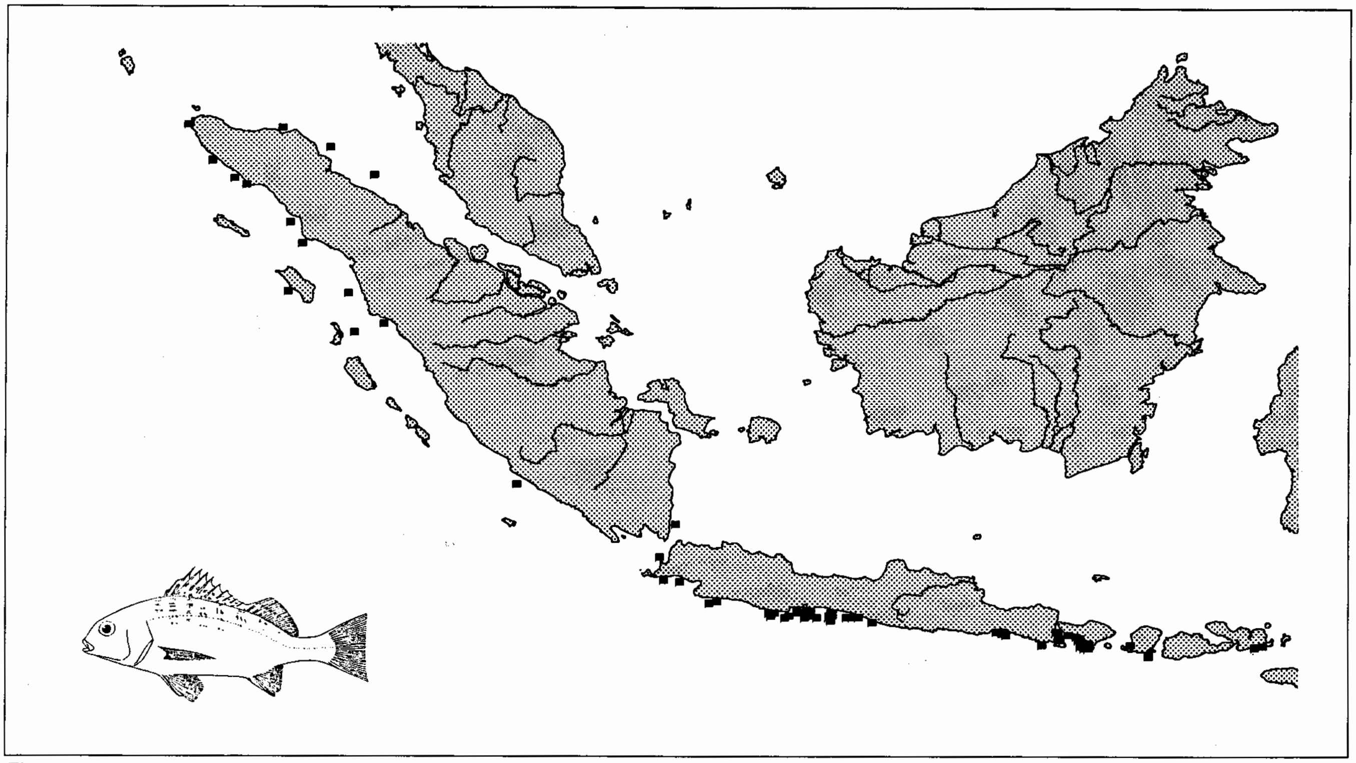

Fig. 55. Distribution of saddle grunt, *Pomadasys maculatus*, in Western Indonesia based on records of the surveys of *R/Vs Mutiara 4, Dr. Fridtjof Nansen*, *Jurong* and *Bawal Putih 2.*
[Gambar 55. Penyebaran ikan gerot-gerot, Pomadasys maculatus, *di Indonesia bagian barat berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Dr. Fridtjof Nansen, Jurong *dan* Bawal Putih 2.*]*

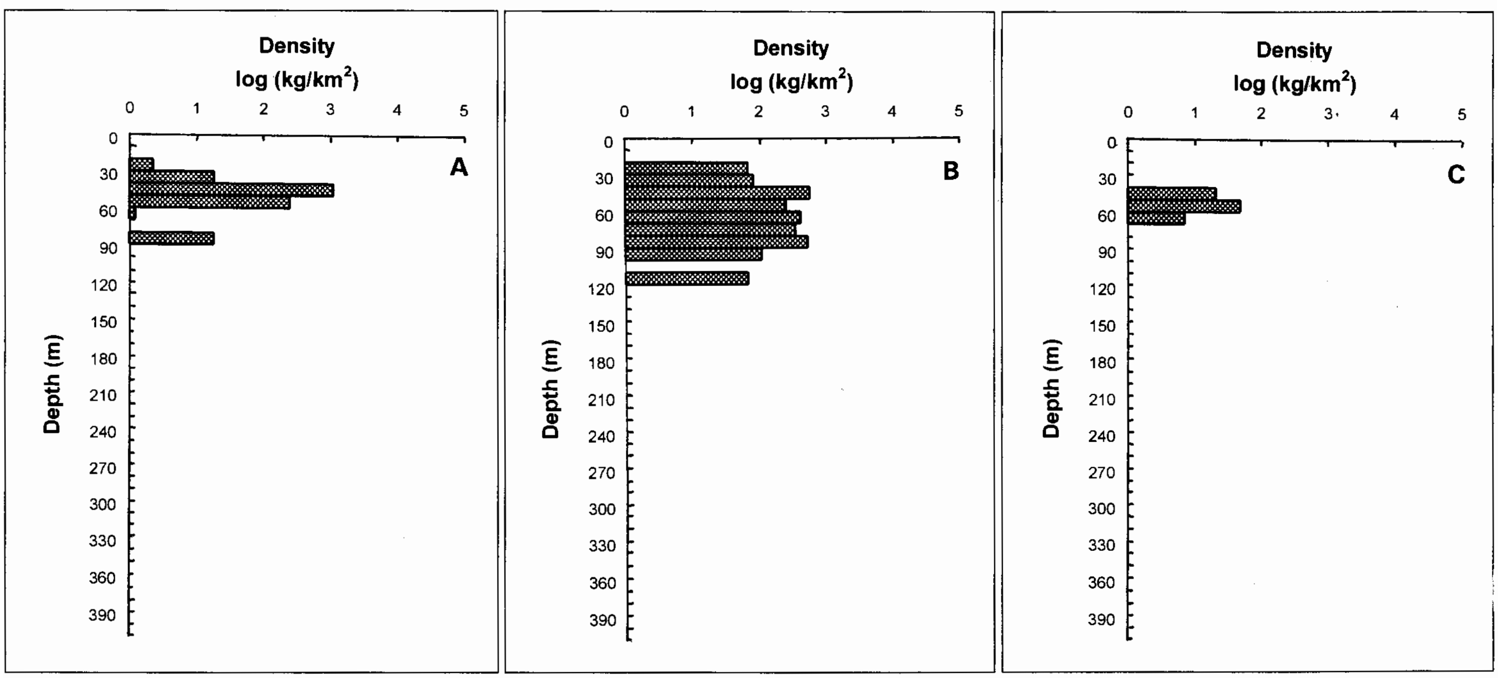

Fig. 56. Depth distribution of saddle grunt, *Pomadasys maculatus,* in Western Indonesia based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen*, (B) *Jurong* and (C) *Bawal Putih 2.*
[Gambar 56. Penyebaran kedalaman ikan gerot-gerot, Pomadasys maculatus, *di Indonesia bagian barat berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen, *(B)* Jurong *dan (C)* Bawal Putih 2.*]*

Lactarius lactarius (Bloch & Schneider, 1801)

False trevally (English); Ikan susu (Indonesian); Lemahan, Limat, Tana (Java); Ikan lemah, Lelemah, Lemah, Susu (West Java, Jakarta); Klemes (Madura); Tambi-tambi (South Borneo); Bebete lubangang (South Sulawesi, Badjo).

Silvery gray with blue iridescence dorsally, silvery white ventrally; upper part of gill cover with a dusky black spot; fins pale yellow. Mouth large and oblique. Dorsal spines: 8-9; soft rays: 20-22; anal spines: 3-3; soft rays: 25-28. L_{max1} = 40 cm; L_{max2} = n.a.; L_{max3} = 29.1 cm TL (Fig. 57A). See Fig. 57B and Table 33 for length-weight relationship.

From the eastern Indian Ocean to Southeast Asia, extending northward to Japan, and southeastward through the Indonesian Archipelago (Fig. 58) to Queensland, Australia.

Occurs in coastal waters; depth range: 15-90 m (Fig. 59). Feeds on sand-dwelling and other benthic and zooplanktonic animals.

References: 312, 1012, 2857, 2872, 3404, 3423, 4789, 4931, 5193, 5213, 5736, 5756, 5978, 6313, 6567, 7300

Table 33. Length-weight (g/[TL;cm]) relationship of false trevally, *Lactarius lactarius*, in Indonesia.
Tabel 33. Hubungan panjang-berat (g/[TL;cm]) ikan susu, Lactarius lactarius*, di Indonesia.*

Parameter	Estimate
a	0.0098
s.e.(a)	0.0034
b	3.0469
s.e.(b)	0.1237
r^2	0.9942

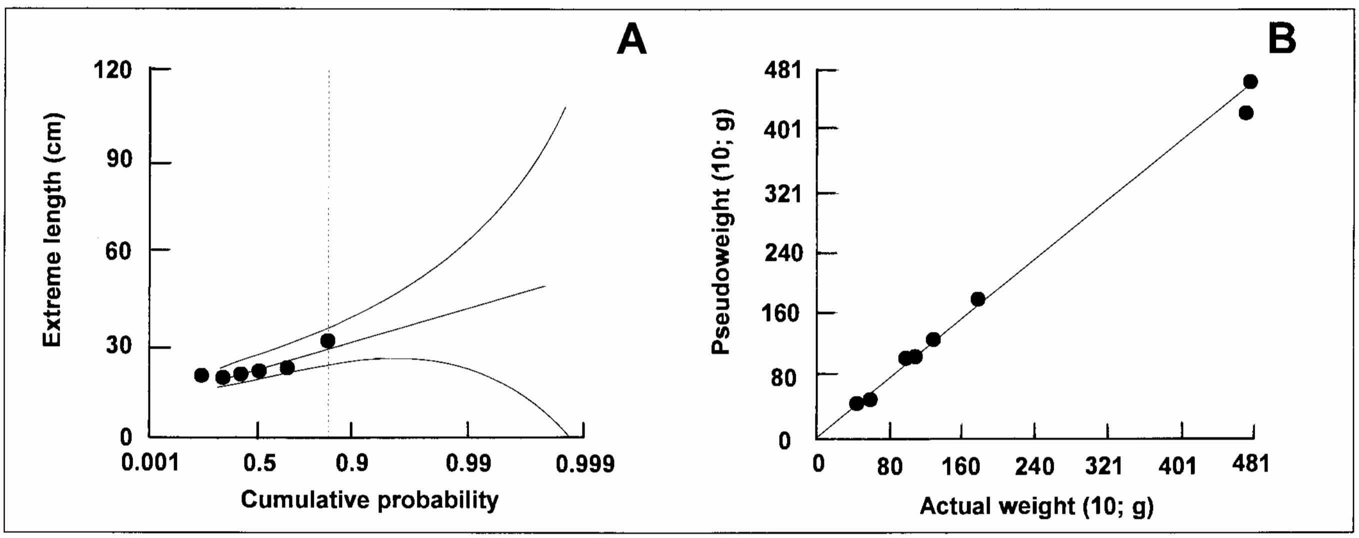

Fig. 57. (A) Extreme value plot for false trevally, *Lactarius lactarius*, in Indonesia based on data from *R/Vs Mutiara 4, Jurong* and *Dr. Fridtjof Nansen* showing maxima of 6 length-frequency samples, and estimate of L_{max3} = 29.1 ± 4.97 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 8 length-frequency samples of false trevally, *Lactarius lactarius*, from Western Indonesia based on data from *R/Vs Mutiara 4, Jurong* and *Dr. Fridtjof Nansen* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 33).

[Gambar 57. (A) Gambaran nilai ekstrim untuk ikan susu, Lactarius lactarius*, di Indonesia berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Jurong *dan* Dr. Fridtjof Nansen *menunjukkan nilai maksimum untuk 6 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 29.1 ± 4.97 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 8 contoh frekuensi-panjang dari ikan susu,* Lactarius lactarius*, dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Jurong *dan* Dr. Fridtjof Nansen *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 33).*

Leiognathus splendens (Cuvier, 1829)

Splendid ponyfish (English); Bondol (Indonesian); Dodok, Gempar, Gemper (Java); Peperek Tjina (West Java, Jakarta); Bondol (West Java, Bandung).

Belly silvery; back grayish silvery with faint, gray wavy vertical lines above lateral lines in adults; lateral line scales and pectoral fin base yellow; pectoral axis black. Scales small and deciduous. Nuchal spine with a distinct median keel. Chest fully scaled. Mouth horizontal, pointing slightly downward when protracted; line of closed mouth passing below eye; a narrow brown band around end of snout. Lower edge of operculum and margin of supraorbital serrated. Third and fourth dorsal and third anal spines anteriorly serrated. Dorsal spines: 7-8; soft rays: 15-17; anal spines: 3-3; soft rays: 13-14. L_{max1} = 17 cm TL; L_{max2} = n.a.; L_{max3} = 21.1 cm TL (Fig. 60A). See Fig. 60B and Table 34 for length-weight relationship.

Indian Ocean: Madagascar and Mauritius to the Red Sea, along the coasts of India and Sri Lanka; Indonesian Archipelago (Fig. 61) and throughout Western Central Pacific, reaching westward to Australia and Fiji.

This schooling species inhabits coastal waters. Depth range: 10-100 m (Fig. 62). Feeds on small fish, crustaceans, foraminiferans, and bivalves. Table 35 presents four sets of growth parameters from Indonesia.

References: 312, 393, 559, 560, 573, 1139, 1263, 1314, 1449, 1486, 1539, 1617, 1633, 1724, 1830, 1918, 2045, 2089, 2108, 2178, 2462, 2504, 2505, 2682, 3131, 3151, 3424, 3430, 3436, 3437, 3438, 3439, 3440, 3441, 3442, 3443, 3444, 3605, 3607, 3614, 3649, 3653, 3655, 3667, 4544, 4880, 4961, 4962, 4963, 5213, 5346, 5381, 5450, 5525, 5736, 5756, 5978, 6192, 6313, 6567, 6992, 7050, 7100

Table 34. Length-weight (g/[TL;cm]) relationship of splendid ponyfish, *Leiognathus splendens*, in Indonesia.
[Tabel 34. Hubungan panjang-berat (g/[TL;cm]) ikan bondol, Leiognathus splendens, *di Indonesia.]*

Parameter	Estimates A	Estimates B
a	0.0112	0.0168
s.e.(a)	n.a.	0.0104
b	3.2170	3.0392
s.e.(b)	n.a.	0.2612
r^2	n.a.	0.9707

A. Northwestern coast of Java (Ref. 2089)
B. This study

Table 35. Growth parameters of splendid ponyfish, *Leiognathus splendens*.
[Tabel 35. Parameter pertumbuhan ikan bondol, Leiognathus splendens.*]*

Parameter	Indonesia A	B	C	D
L_∞ (TL, cm)	14	14.5	16.7	16.9
K (year^{-1})	1.04	1.25	0.90	1.10

A. Southern Kalimantan (Ref. 1139)
B. Riau (Bintan) (Ref. 1314)
C. Java Sea (Central Java) (Ref. 1314)
D. Java Sea (South Kalimantan) (Ref. 1314)

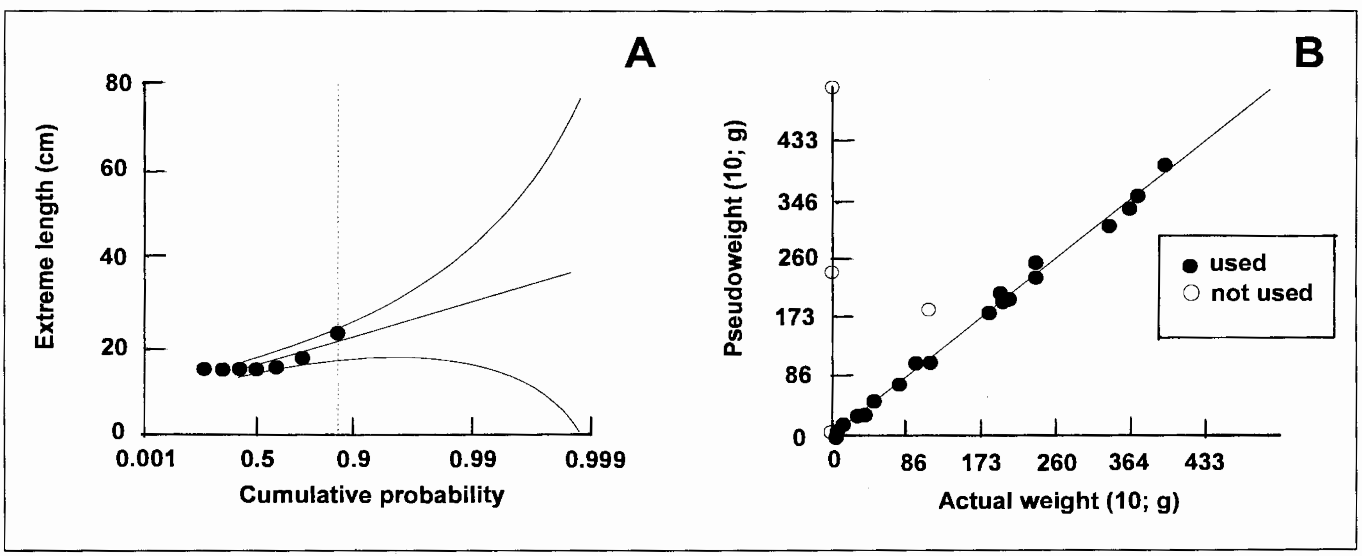

Fig. 60. (A) Extreme value plot for splendid ponyfish, *Leiognathus splendens,* in Indonesia based on data from *R/Vs Mutiara 4, Dr. Fridtjof Nansen* and *Jurong* showing maxima of 7 length-frequency samples, and estimate of L_{max3} = 21.1 $\pm$ 3.35 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 19 length-frequency samples of splendid ponyfish, *Leiognathus splendens*, from Western Indonesia based on data from *R/Vs Mutiara 4,* Jurong and *Dr. Fridtjof Nansen* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 34). Open dots represent outliers, not used for analysis.
[Gambar 60. (A) Gambaran nilai ekstrim ikan bondol, Leiognathus splendens, *di Indonesia berdasarkan data survei kapal-kapal penelitian* Mutiara 4, Dr. Fridtjof Nansen *dan* Jurong *yang menunjukkan 7 contoh frekuensi-panjang dan angka perkiraan L_{max3} = 21.1 $\pm$ 3.35 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 19 contoh frekuensi-panjang ikan bondol,* Leiognathus splendens, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Jurong *dan* Dr. Fridtjof Nansen *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 34). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

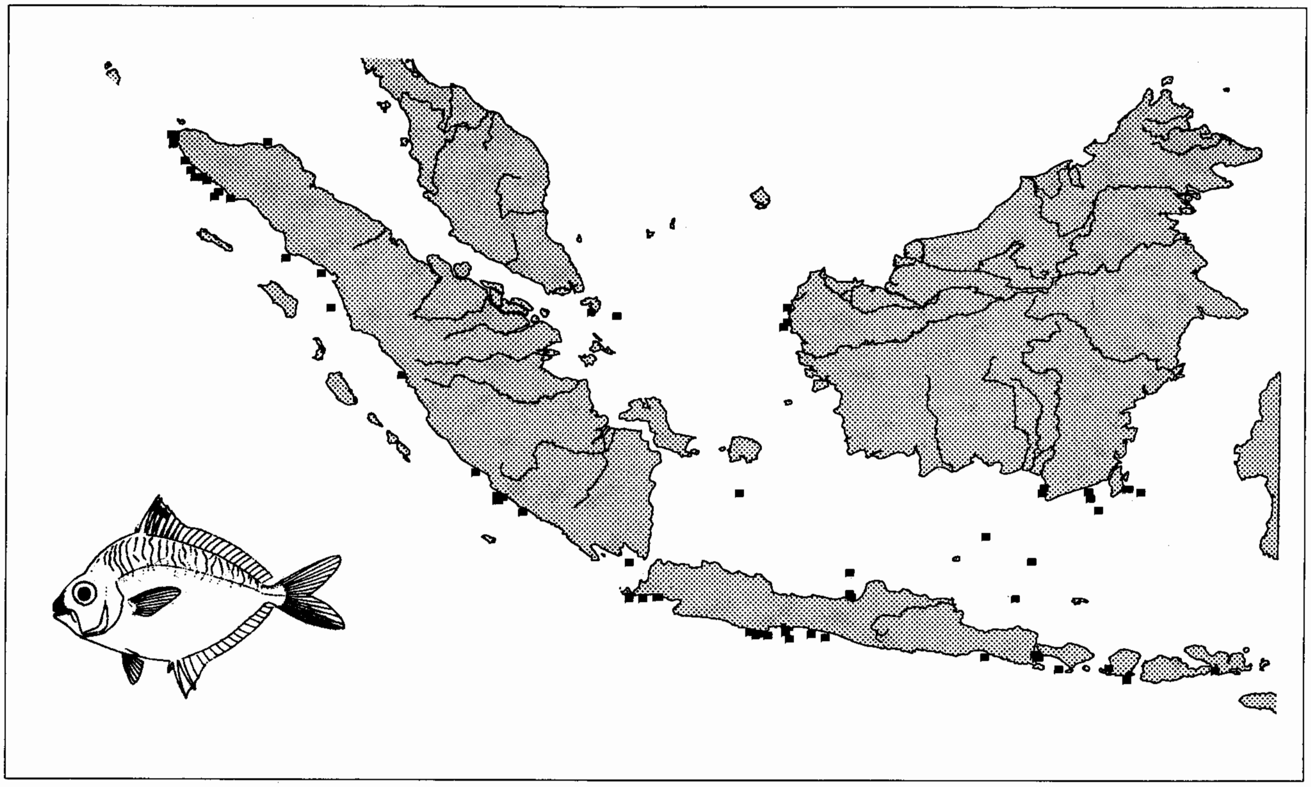

Fig. 61. Distribution of splendid ponyfish, *Leiognathus splendens*, based on records of the surveys of *R/Vs Mutiara 4*, *Bawal Putih 2, Jurong* and *Dr. Fridtjof Nansen.*

[Gambar 61. Penyebaran ikan bondol, Leiognathus splendens, *berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong *dan* Dr. Fridtjof Nansen.*]*

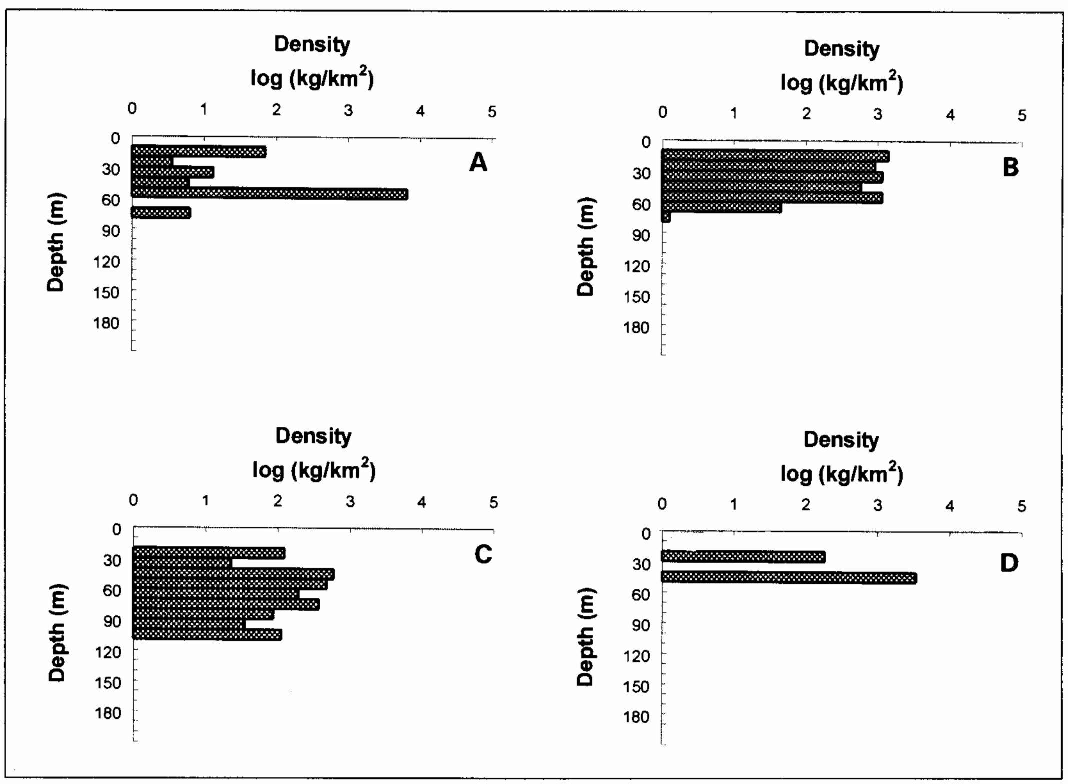

Fig. 62. Depth distribution of splendid ponyfish, *Leiognathus splendens*, based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen,* (B) *Mutiara 4,* (C) *Jurong* and (D) *Bawal Putih 2.*

[Gambar 62. Penyebaran kedalaman ikan bondol, Leiognathus splendens, *berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen, *(B)* Mutiara 4, *(C)* Jurong *dan (D)* Bawal Putih 2.*]*

Leiognathus bindus (Valenciennes, 1835)

Orangefin ponyfish (English); Tjaria (Indonesian); Petah (Java); Peperek (West Java, Jakarta); Tjaria (South Sulawesi, Bugis).

Silvery body; snout with a dark band; dorsal and anal fins with orange tips. Head naked; with nuchal spine. Mouth pointing forward when protracted. Breast with small scales. Dorsal spines: 8-8; soft rays: 16-16; anal spines: 3-3; soft rays: 14-14. L_{max1} = 14 cm; L_{max2} = n.a.; L_{max3} = 14.8 cm TL (Fig. 63A). See Fig. 63B and Table 36 for length-weight relationship.

Indian Ocean: Red Sea (Port Sudan), Persian Gulf, India, Sri Lanka, Bangladesh. Western Central Pacific, including Indonesia (Fig. 64) and Australia; also reported from New Caledonia.

Found in shallow waters. Depth range: 10-100 m (Fig. 65). Forms schools. Table 37 presents a set of growth parameters from Indonesia.

References: 312, 393, 1015, 1016, 1263, 1314, 1372, 1403, 1449, 1486, 2044, 2088, 2108, 2857, 3424, 3605, 4789, 5346, 5381, 5525, 5756, 6365, 6567

Table 36. Length-weight (g/[TL;cm]) relationship of orangefin ponyfish, *Leiognathus bindus,* in Indonesia.
[Tabel 36. Hubungan panjang-berat (g/[TL;cm]) ikan caria, Leiognathus bindus, *di Indonesia.]*

Parameter	Estimate
a	0.0182
s.e.(a)	0.0044
b	2.9191
s.e.(b)	0.1210
r^2	0.9902

Table 37. Growth parameters of orangefin ponyfish, *Leiognathus bindus.*
[Tabel 37. Parameter pertumbuhan ikan caria, Leiognathus bindus.*]*

Parameter	A
L_∞ (TL, cm)	12.5
K ($year^{-1}$)	1.38

A. Java Sea (Central Java) (Ref. 1314)

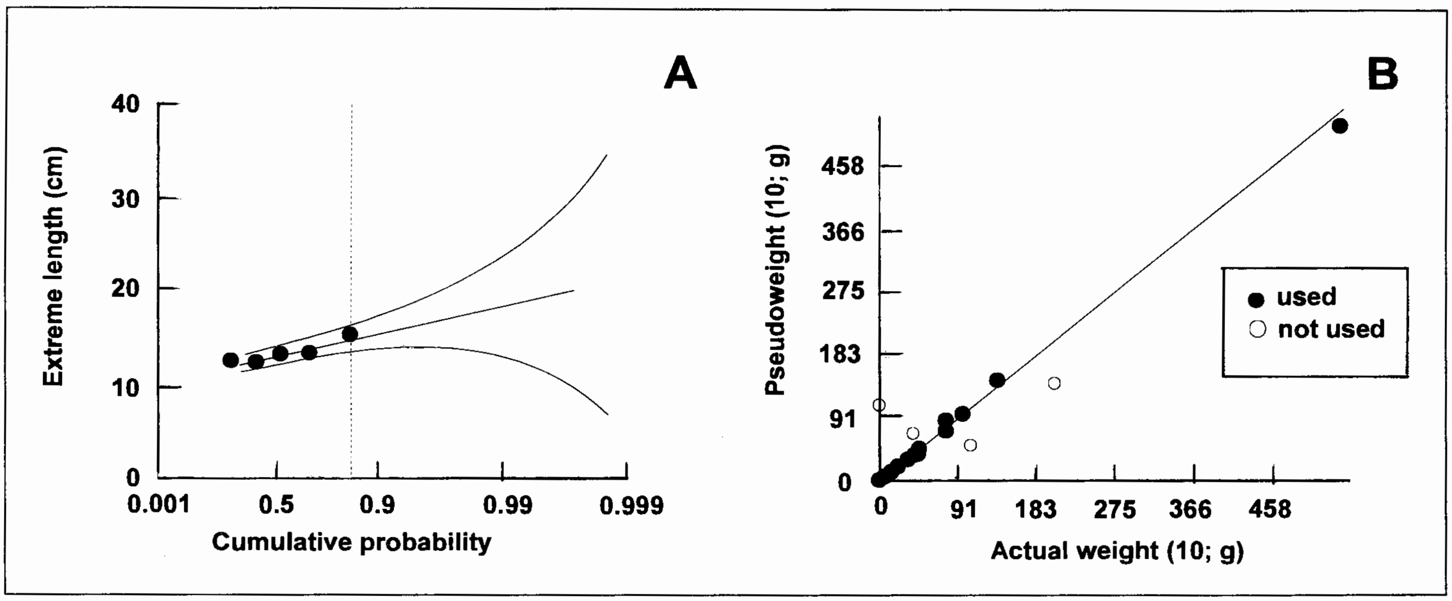

Fig. 63. (A) Extreme value plot for orangefin ponyfish, *Leiognathus bindus*, in Indonesia based on data from *R/V Jurong* showing maxima of 5 length-frequency samples, and estimate of L_{max3} = 14.8 ± 1.15 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 17 length-frequency samples of orangefin ponyfish, *Leiognathus bindus*, from Western Indonesia based on data from *R/Vs Mutiara 4, Jurong* and *Dr. Fridtjof Nansen* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 35). Open dots represent outliers, not used for analysis.
[Gambar 63. (A) Gambaran nilai ekstrim untuk ikan caria, Leiognathus bindus, *di Indonesia berdasarkan data dari kapal penelitian* Jurong *menunjukkan 5 contoh frekuensi-panjang dan angka perkiraan L_{max3} = 14.8 ± 1.15 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 17 contoh frekuensi-panjang ikan caria,* Leiognathus bindus, *dari Indonesia bagian barat berdasarkan data kapal-kapal penelitian* Mutiara 4, Jurong *dan* Dr. Fridtjof Nansen *sebagai output perangkat lunak ABee (lihat Boks 1), yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 35). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

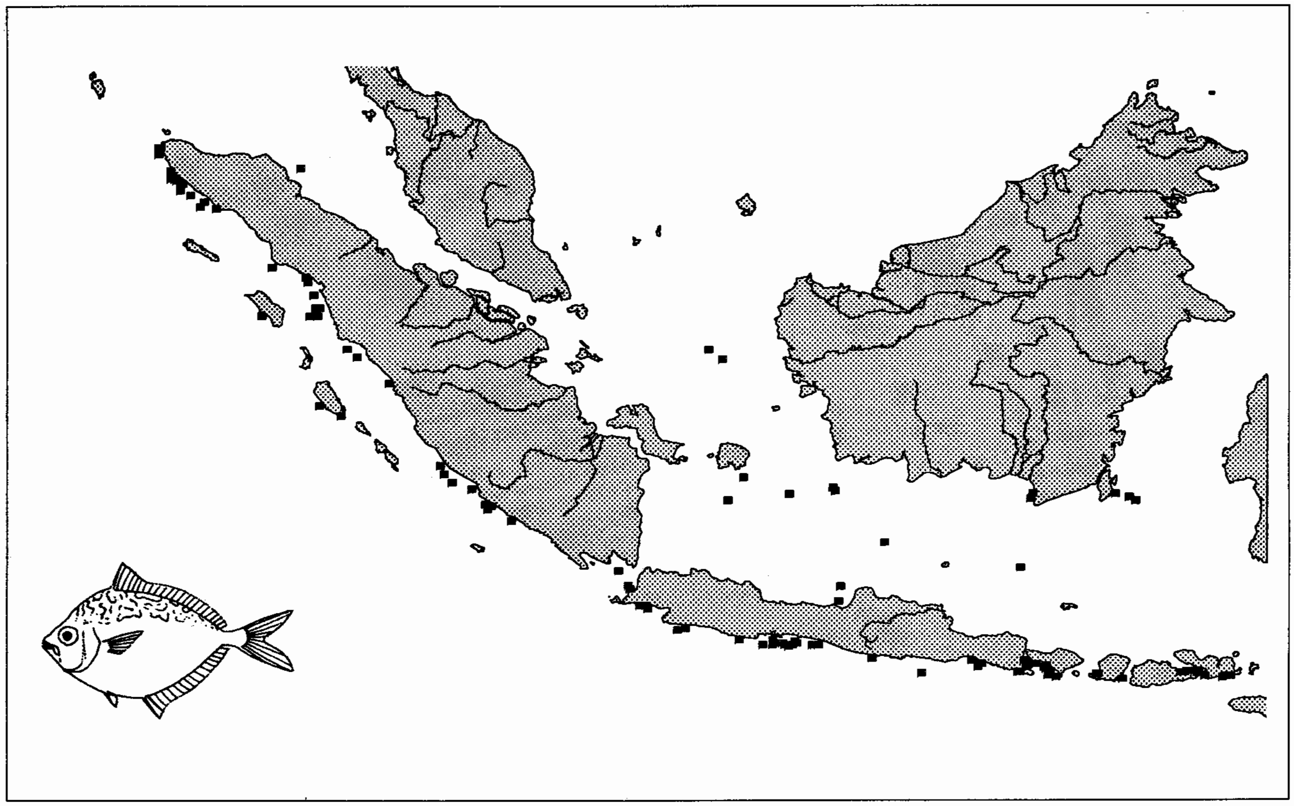

Fig. 64. Distribution of orangefin ponyfish, *Leiognathus bindus,* based on records of the surveys of *R/Vs Mutiara 4, Bawal Putih 2, Jurong* and *Dr. Fridtjof Nansen.*
[Gambar 64. Penyebaran ikan caria, Leiognathus bindus, *berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong *dan* Dr. Fridtjof Nansen.*]*

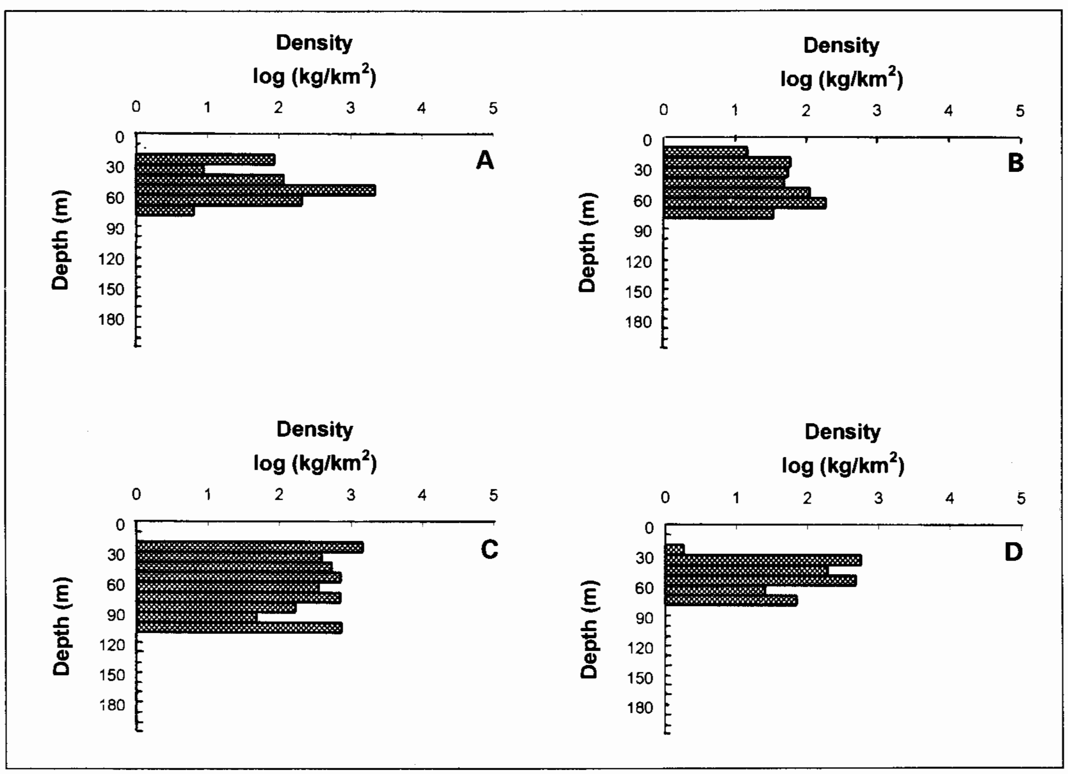

Fig. 65. Depth distribution of orangefin ponyfish, *Leiognathus bindus*, based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen,* (B) *Mutiara 4,* (C) *Jurong* and (D) *Bawal Putih 2.*
[Gambar 65. Penyebaran kedalaman ikan caria, Leiognathus bindus, *berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen, *(B)* Mutiara 4, *(C)* Jurong *dan (D)* Bawal Putih 2.*]*

Leiognathus equulus (Forsskål, 1775)

Common ponyfish (English); Peperek topang (Indonesian); Dodok (Java); Perek topang, Peperek topang, Peperek Tjina (West Java, Jakarta); Lokmolok (Madura); Molok-molok (Madura); Petek kuning (South Borneo); Bebete (South Sulawesi, Badjo).

Body silvery; caudal peduncle with a small brown saddle; anal fins yellowish; dorsal fin transparent. Strongly arched back. Naked head, with nuchal spine. Protracted mouth pointing downward. Dorsal spines: 8-8; soft rays: 16-16; anal spines: 3-3; soft rays: 14-14. L_{max1} = 25 cm TL; L_{max2} = n.a.; L_{max3} = 28.4 cm TL (Fig. 66A). See Fig. 66B and Table 38 for length-weight relationship.

Indo-West Pacific: from East London, South Africa including Réunion, Comores, Seychelles, Madagascar and Mauritius, Zanzibar, the Red Sea, Persian Gulf, India and Sri Lanka and thence to Southeast Asia and the islands of Indonesia (Fig. 67). Northeast to Okinawa, Ryukyu Islands; south to Australia and Fiji.

Occurs in river mouths and muddy inshore areas. Depth range: 10-110 m (Fig. 68). Feeds on polychaetes, small crustaceans, and small fish. Table 39 presents a set of growth parameters from Indonesia.

References: 186, 312, 393, 986, 1263, 1314, 1449, 1486, 1602, 2029, 2108, 2857, 3424, 3605, 3670, 3678, 4789, 4867, 4959, 5213, 5301, 5339, 5346, 5381, 5525, 5736, 5756, 6026, 6313, 6567

Table 38. Length-weight (g/[TL;cm]) relationship of common ponyfish, *Leiognathus equulus*, in Indonesia.
[Tabel 38. Hubungan panjang-berat (g/[TL;cm]) ikan peperek topang, Leiognathus equulus, *di Indonesia.]*

Parameter	Estimate
a	0.0023
s.e.(a)	0.0031
b	3.6738
s.e.(b)	0.4120
r^2	0.9398

Table 39. Growth parameters of common ponyfish, *Leiognathus equulus.*
[Table 39. Parameter pertumbuhan ikan peperek topang, Leiognathus equulus.*]*

Parameter	A
L_∞ (TL, cm)	21.5
K ($year^{-1}$)	1.50

A. Java Sea (Central Java) (Ref. 1314)

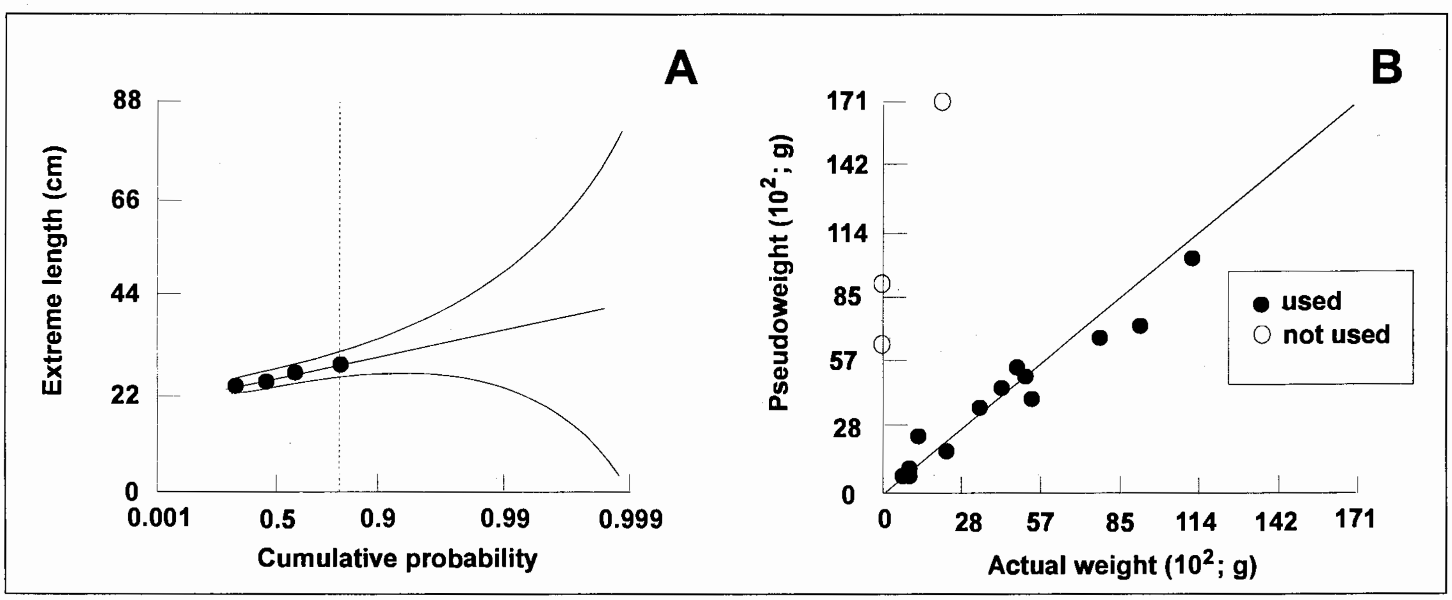

Fig. 66. (A) Extreme value plot for common ponyfish, *Leiognathus equulus*, in Indonesia based on data from *R/Vs Mutiara 4* and *Jurong* showing maxima of 4 length-frequency samples, and estimate of L_{max3} = 28.4 ± 2.65 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 14 length-frequency samples of common ponyfish, *Leiognathus equulus*, from Western Indonesia based on data from *R/Vs Mutiara 4*, *Jurong* and *Dr. Fridtjof Nansen as* output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 37). Open dot(s) represent outliers, not used for analysis.
[Gambar 66. (A) Gambaran nilai ekstrim ikan peperek topang, Leiognathus equulus, *di Indonesia berdasarkan data dari kapal-kapal penelitian* Mutiara 4 *dan* Jurong *yang menunjukkan nilai maksimum untuk 4 contoh frekuensi-panjang dan angka perkiraan* L_{max3} *= 28.4 ± 2.65 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 14 contoh frekuensi-panjang ikan peperek topang,* Leiognathus equulus, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Jurong *dan* Dr. Fridtjof Nansen *sebagai output perangkat lunak ABee (lihat Boks 1), dan memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 37). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

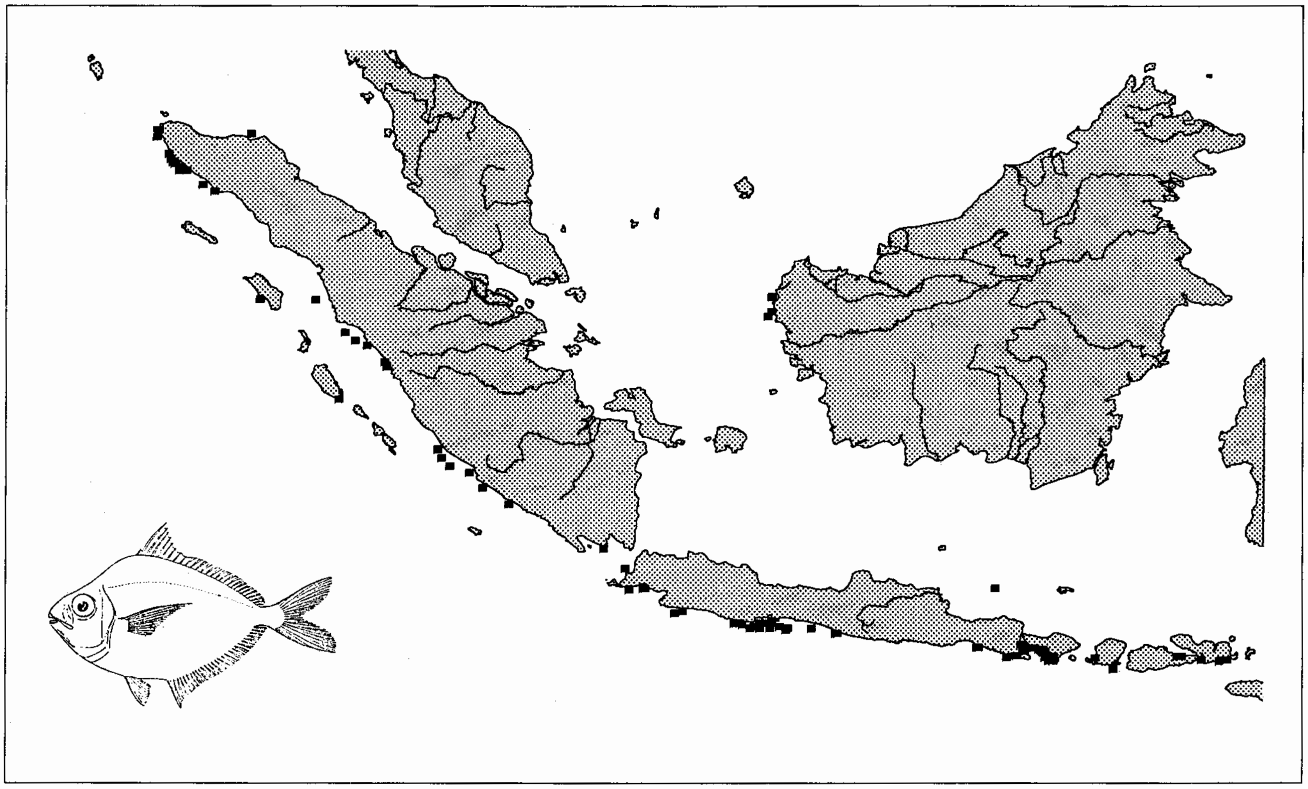

Fig. 67. Distribution of common ponyfish, *Leiognathus equulus,* based on records of the surveys of *R/Vs Mutiara 4*, *Bawal Putih 2, Jurong* and *Dr. Fridtjof Nansen.*
[Gambar 67. Penyebaran ikan peperek topang, Leiognathus equulus, *berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong *dan* Dr. Fridtjof Nansen.*]*

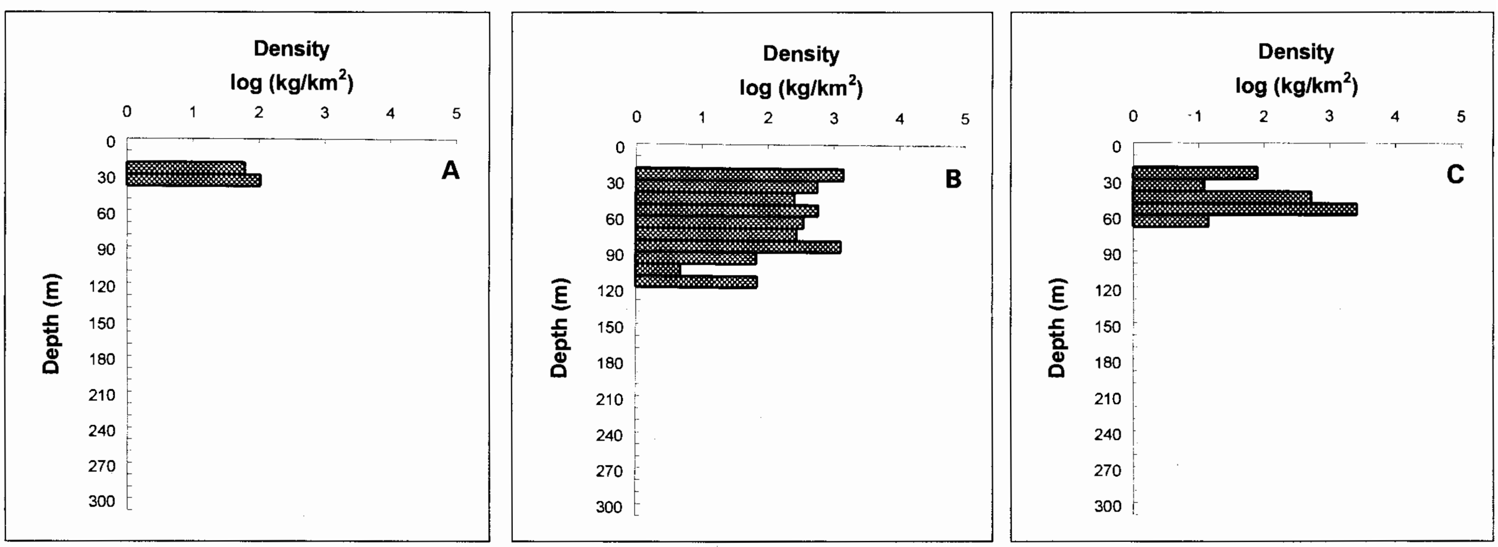

Fig. 68. Depth distribution of common ponyfish, *Leiognathus equulus*, based on surveys of *R/Vs* (A) *Mutiara 4,* (B) *Jurong* and (C) *Bawal Putih 2.*
[Gambar 68. Penyebaran kedalaman ikan peperek topang, Leiognathus equulus, *berdasarkan survei kapal-kapal penelitian (A)* Mutiara 4, *(B)* Jurong *dan (C)* Bawal Putih 2.*]*

Gymnocranius grandoculis (Valenciennes, 1830)

Rippled barenose.

Forehead profile moderately steep; large adults develop a bony ridge on the nape and a bony shelf over the front part of the eye. The inner surface of the pectoral fin axil is scaleless. Overall color is silvery with thin brown scale margins. The anterior half of the head is often brown with a series of narrow undulating, longitudinal lines on the cheek and side of the snout. Fins are yellow or orange; caudal fin is frequently dusky brown; a narrow brown bar across the base of pectoral fins. Juveniles under about 25 cm SL often with 5 or 6 dark bars on the side and a dark bar below the eye. Dorsal spines: 10-10; soft rays: 10-10; anal spines: 3-3; soft rays: 10-10. L_{max1} = 80 cm TL; L_{max2} = n.a.; L_{max3} = 74.3 cm FL (Fig. 75A). See Fig. 75B and Table 43 for length-weight relationship.

Widely distributed from East Africa in the Indian Ocean via Southeast Asia to Japan in the north, and Indonesia (Fig. 76), Australia and Oceania.

Inhabits trawling grounds of the continental shelves and offshore rocky bottoms. Depth range: 20-170 m (Fig. 77). Feeds mostly on benthic invertebrates and small fishes.

References: 171, 1830, 2030, 2290, 2295, 4537, 4830, 5213, 5450, 5525, 5756, 6567

Table 43. Length-weight (g/[FL;cm]) relationship of rippled barenose, *Gymnocranius grandoculis*, in Indonesia.
[Tabel 43. Hubungan panjang-berat (g/[FL;cm]) ikan Gymnocranius grandoculis, *di Indonesia.]*

Parameter	Estimate
a	0.2492
s.e.(a)	0.1445
b	2.3647
s.e.(b)	0.1538
r^2	0.8875

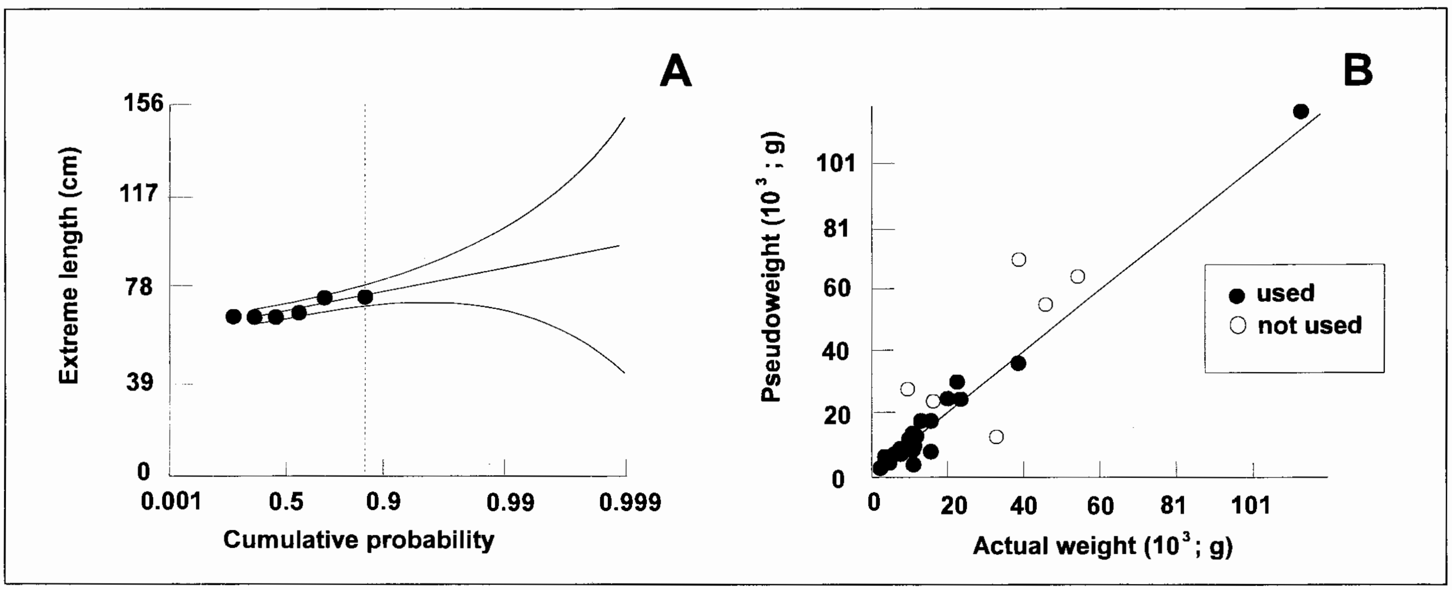

Fig. 75. (A) Extreme value plot for rippled barenose, *Gymnocranius grandoculis*, in Indonesia based on data from *R/V Jurong* showing maxima of 6 length-frequency samples, and estimate of L_{max3} = 74.3 ± 4.3 cm FL. (B) Predicted *vs.* observed weights (in g wet weight) of 31 length-frequency samples of rippled barenose, *Gymnocranius grandoculis*, from Western Indonesia based on data from *R/Vs Mutiara 4, Jurong* and *Bawal Putih 2* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 43). Open dots represent outliers, not used for analysis. *[Gambar 75. (A) Gambaran nilai ekstrim ikan* Gymnocranius grandoculis *di Indonesia berdasarkan data dari kapal penelitian* Jurong *menunjukkan nilai maksimum untuk 6 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 74.3 ± 4.3 cm FL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 31 contoh frekuensi-panjang ikan* Gymnocranius grandoculis *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Jurong *dan Bawal Putih 2 sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 43). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

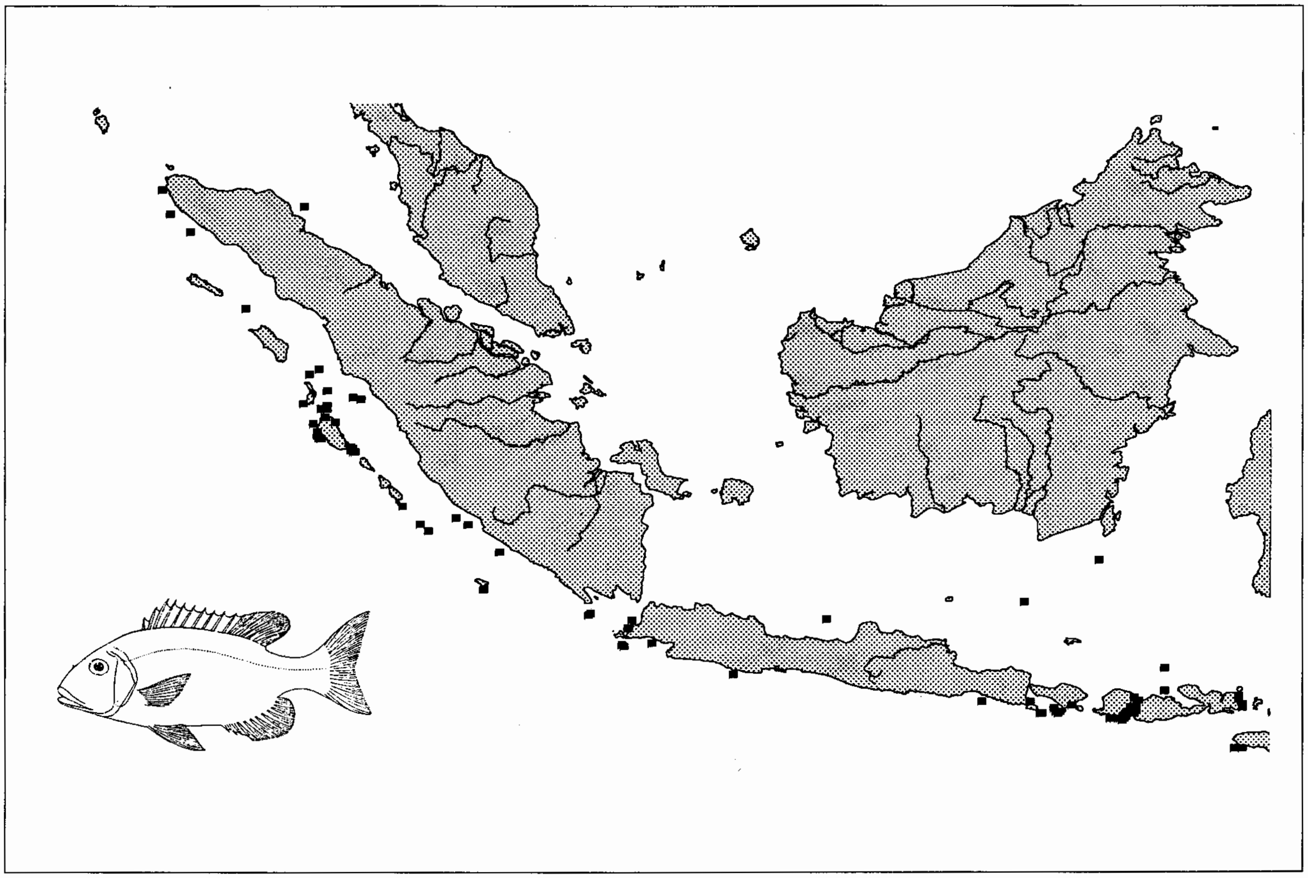

Fig. 76. Distribution of rippled barenose, *Gymnocranius grandoculis*, based on records of the surveys of *R/Vs Mutiara 4, Bawal Putih 2, Jurong* and *Dr. Fridtjof Nansen*.
[Gambar 76. Penyebaran ikan Gymnocranius grandoculis *berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong *dan Dr. Fridtjof Nansen.]*

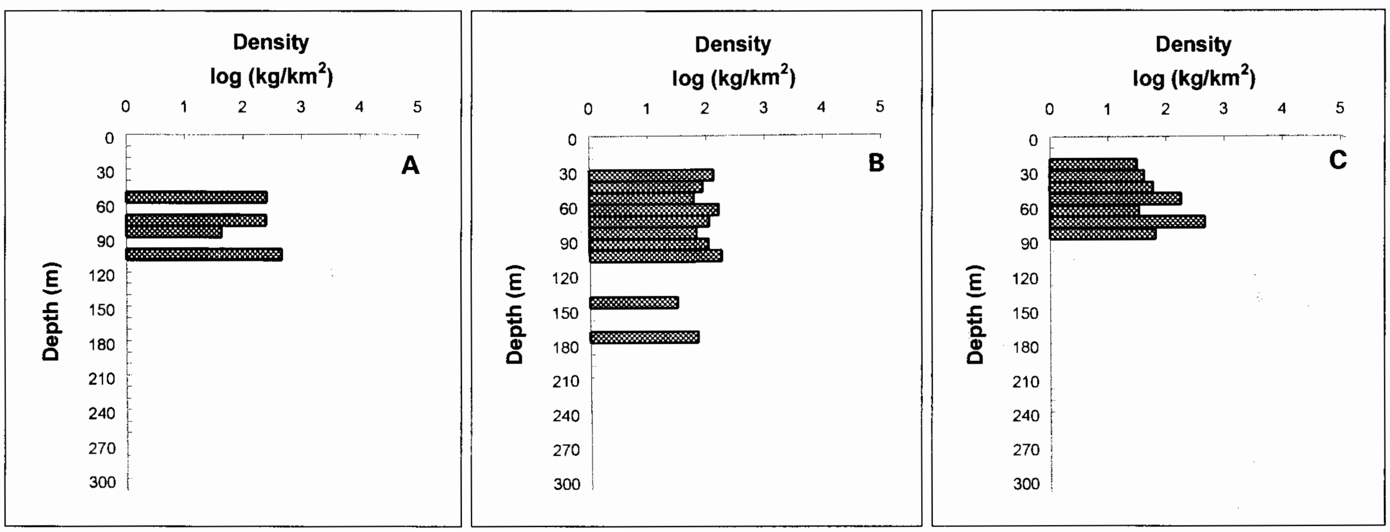

Fig. 77. Depth distribution of rippled barenose, *Gymnocranius grandoculis*, based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen,* (B) *Jurong* and (C) *Bawal Putih 2*.
[Gambar 77. Penyebaran kedalaman ikan Gymnocranius grandoculis *berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen, *(B)* Jurong *dan (C)* Bawal Putih 2.*]*

Aprion virescens (Valenciennes, 1830)

Green jobfish.

Preopercle edge smooth or sometimes denticulate in juveniles. There is a distinct horizontal groove in front of eye. Dorsal and anal fins scaleless. Scale rows on back parallel with lateral line. Color dark green to bluish or blue-gray. Dorsal spines: 10-10; soft rays: 11-11; anal spines: 3-3; soft rays: 8-8. L_{max1} = 112 cm TL; L_{max2} = n.a.; L_{max3} = 86.9 cm FL (Fig. 78A). See Fig. 78B and Table 44 for length-weight relationship.

Widely distributed in the tropical Indo-Pacific Ocean from East Africa via Southeast Asia to southern Japan and Hawaii, and southward via Indonesia (Fig. 79) to Australia.

Inhabits inshore reef areas, usually solitary. Depth range: 20-100 m (Fig. 80). Feeds mainly on fishes, but also shrimps, crabs, cephalopods and planktonic organisms.

References: 55, 171, 245, 280, 583, 1602, 1830, 2290, 3084, 3090, 3111, 3670, 3678, 3804, 3807, 4517, 4690, 4699, 4795, 4821, 4868, 4887, 5213, 5358, 5450, 5525, 5579, 5736, 5756, 6089, 6273, 6306, 6365

Table 44. Length-weight (g/[FL;cm]) relationship of green jobfish, *Aprion virescens,* in Indonesia.
Tabel 44. Hubungan panjang-berat (g/[FL;cm]) ikan Aprion virescens *di Indonesia.*

Parameter	Estimate
a	0.0077
s.e.(a)	0.0039
b	3.1368
s.e.(b)	0.1181
r^2	0.9922

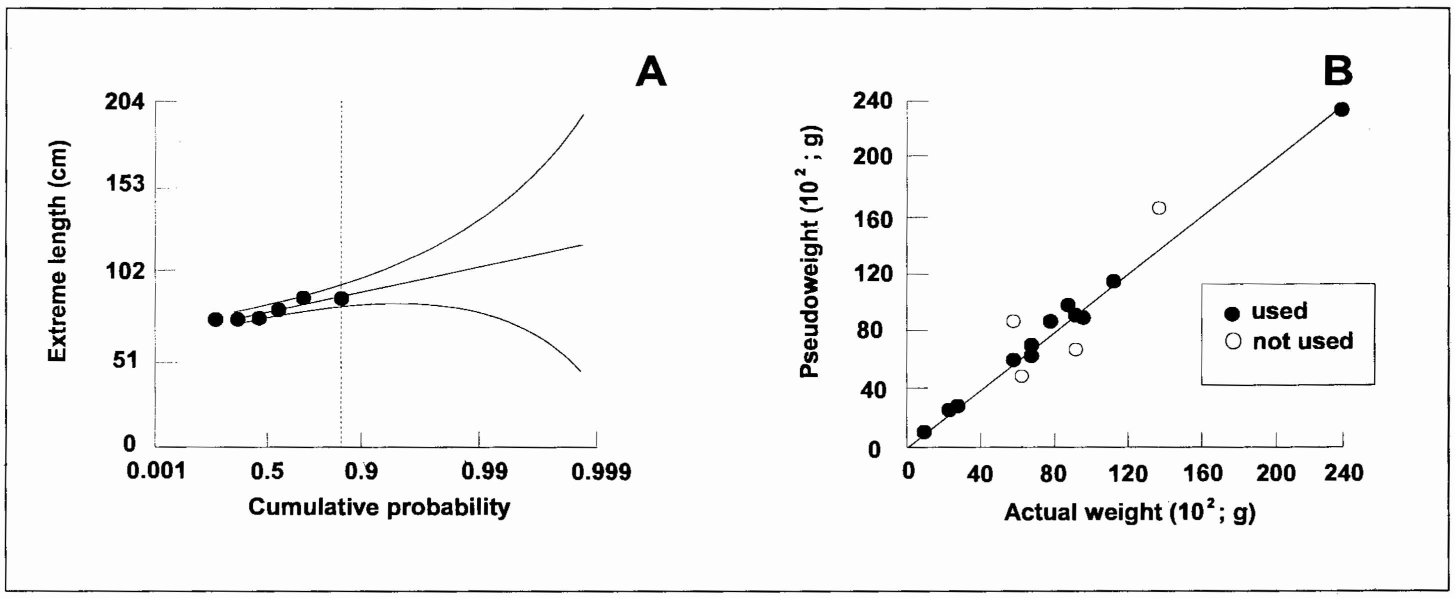

Fig. 78 (A) Extreme value plot for green jobfish, *Aprion virescens,* in Indonesia based on data from *R/V Jurong* showing maxima of 6 length-frequency samples, and estimate of L_{max3} = 86.9 ± 6.5 cm FL. (B) Predicted *vs.* observed weights (in g wet weight) of 12 length-frequency samples of green jobfish, *Aprion virescens*, from Western Indonesia based on data from *R/V Jurong* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 44). Open dots represent outliers, not used for analysis.
[Gambar 78. (A) Gambaran nilai ekstrim ikan Aprion virescens *di Indonesia berdasarkan data dari kapal penelitian* Jurong *yang menunjukkan nilai maksimum untuk 6 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 86.9 ± 6.5 cm FL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 12 contoh frekuensi-panjang ikan* Aprion virescens *dari Indonesia bagian barat berdasarkan data dari kapal penelitian* Jurong *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 44). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

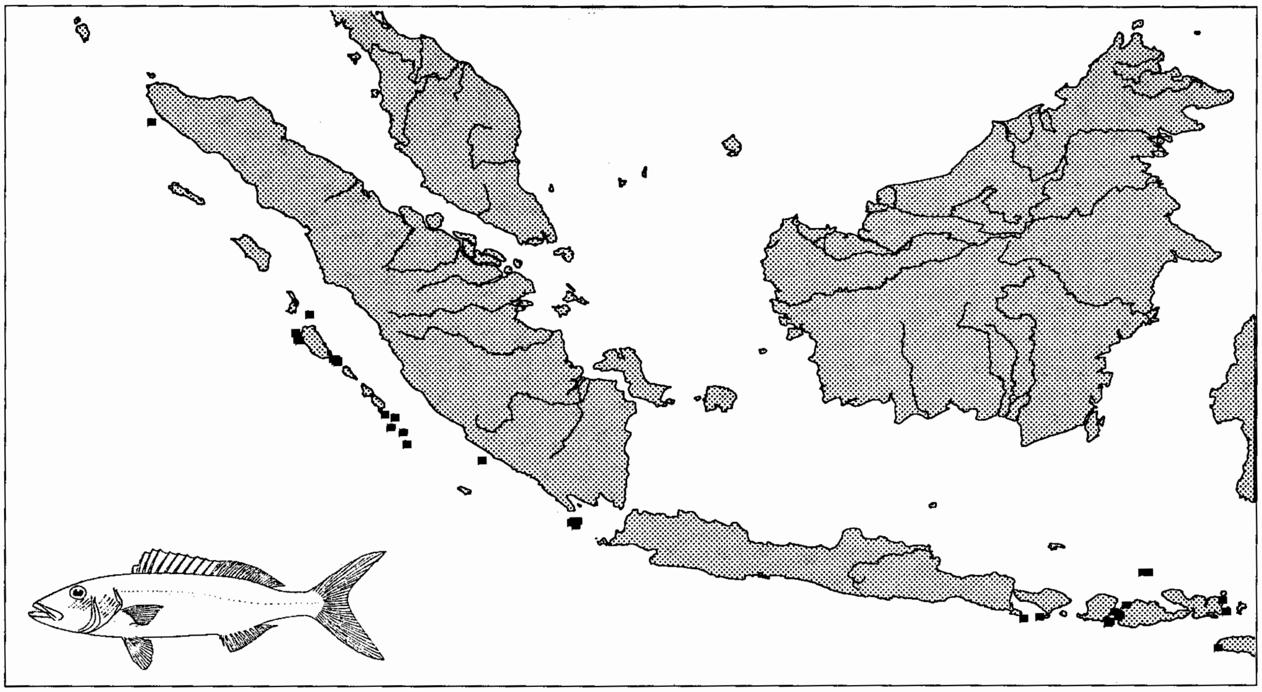

Fig. 79. Distribution of green jobfish, *Aprion virescens,* based on records of the surveys of *R/Vs Bawal Putih 2, Jurong* and *Dr. Fridtjof Nansen.*
[Gambar 79. Penyebaran ikan Aprion virescens *berdasarkan laporan survei kapal-kapal penelitian* Bawal Putih 2, Jurong dan Dr. Fridtjof Nansen.*]*

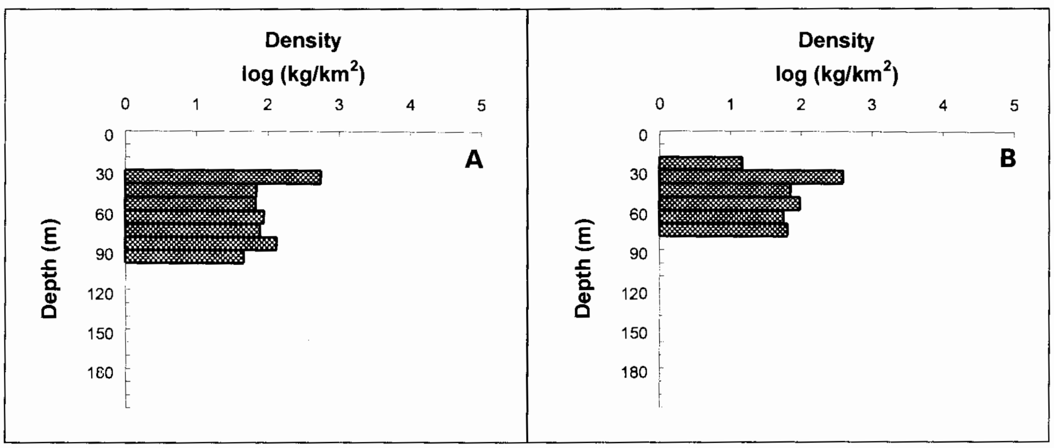

Fig. 80. Depth distribution of green jobfish, *Aprion virescens*, based on surveys of *R/Vs* (A) *Jurong* and (B) *Bawal Putih* 2.
[Gambar 80. Penyebaran kedalaman ikan Aprion virescens *berdasarkan survei kapal-kapal penelitian (A)* Jurong *dan (B)* Bawal Putih 2.*]*

Pristipomoides typus (Bleeker, 1852)

Sharptooth jobfish.

Interorbital space flat. Bases of dorsal and anal fins scaleless, their last soft rays extended into short filaments. Pectoral fins long, reaching level of anus. Scale rows on back parallel to lateral line. Overall color rosy red; the top of the head with longitudinal vermiculated lines and spots of brownish yellow; the dorsal fin with wavy yellow lines. Dorsal spines: 10-10; soft rays: 11-12; anal spines: 3-3; soft rays: 8-8. L_{max1} = 70 cm TL; L_{max2} = n.a.; L_{max3} = 68.3 cm TL (Fig. 81A). See Fig. 81B and Table 45 for length-weight relationship.

Tropical western Pacific ranging in Indonesia from Sumatra to Irian Jaya (Fig 82) and northward to the Ryukyu Islands. Records from the western Indian Ocean need to be confirmed.

Occurs over rocky bottoms. Depth range: 40-120 m (Fig. 83). Feeds on benthic invertebrates and fishes.

References: 55, 171, 438, 1451, 2857, 3090, 4517, 4789, 5213, 5450, 5515, 5725, 5756, 6365, 6425, 6567

Table 45. Length-weight (g/[TL;cm]) relationship of sharptooth jobfish, *Pristipomoides typus*, in Indonesia.
[Tabel 45. Hubungan panjang-berat [g/(TL;cm)] ikan Pristipomoides typus *di Indonesia.]*

Parameter	Estimate
a	0.0143
s.e.(a)	0.0175
b	2.9158
s.e.(b)	0.3156
r^2	0.9208

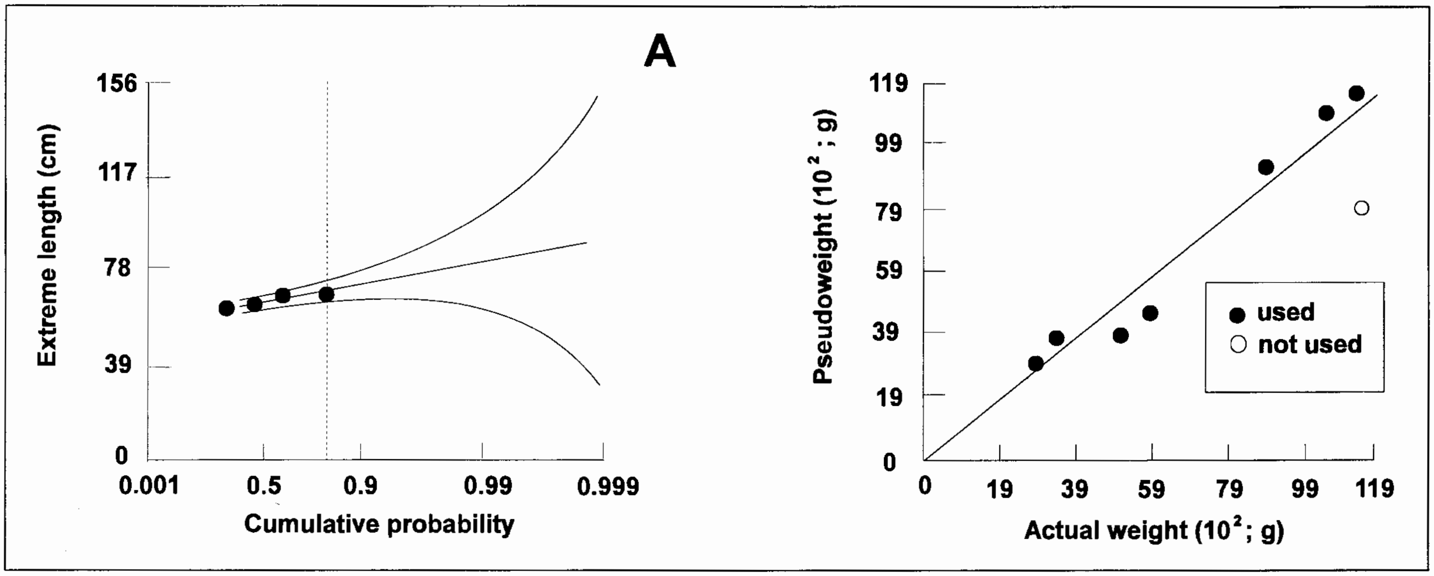

Fig. 81. (A) Extreme value plot for sharptooth jobfish, *Pristipomoides typus*, in Indonesia based on data from *R/Vs Mutiara 4* and *Dr. Fridtjof Nansen* showing maxima of 4 length-frequency samples, and estimate of L_{max3} = 68.3 ± 4.1 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 7 length-frequency samples of sharptooth jobfish, *Pristipomoides typus*, from Western Indonesia based on data from *R/Vs Mutiara 4, Bawal Putih 2* and *Dr. Fridtjof Nansen* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 45). Open dot represents outlier, not used for analysis.
[Gambar 81. (A) Gambaran nilai ekstrim ikan Pristipomoides typus *di Indonesia berdasarkan data dari kapal-kapal penelitian* Mutiara 4 *dan* Dr. Fridtjof Nansen *yang menunjukkan nilai maksimum untuk 4 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 68.3 ± 4.1 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 7 contoh frekuensi-panjang* Pristipomoides typus *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Bawal Putih 2 *dan* Dr. Fridtjof Nansen *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 45). Bulatan kosong mewakili suatu pengamatan yang tidak dipakai dalam analisis.]*

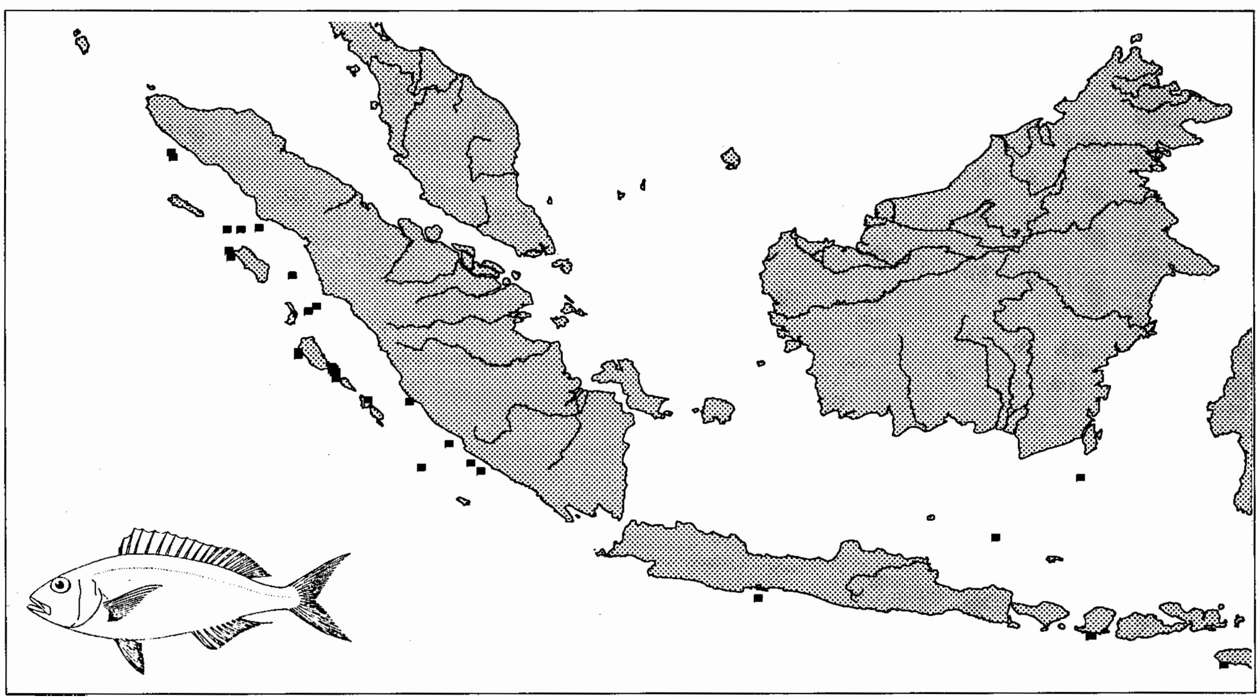

Fig. 82. Distribution of sharptooth jobfish, *Pristipomoides typus*, based on records of the surveys of *R/Vs Mutiara 4, Bawal Putih 2, Jurong* and *Dr. Fridtjof Nansen*.
[Gambar 82. Penyebaran ikan Pristipomoides typus *berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong *dan* Dr. Fridtjof Nansen.*]*

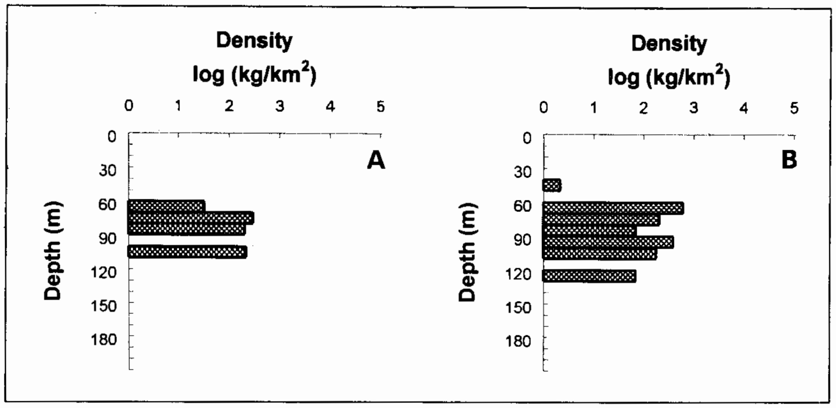

Fig. 83. Depth distribution of sharptooth jobfish, *Pristipomoides typus*, based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen* and (B) *Jurong*. *[Gambar 83. Penyebaran kedalaman ikan* Pristipomoides typus *berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen *dan (B)* Jurong.*]*

Upeneus moluccensis (Bleeker, 1855)

Goldband goatfish (English); Bijinangka (Indonesian).

Body elongate, with relatively large ctenoid scales. Color is silvery white, with a bright yellow horizontal band running through the eye to the caudal fin. Dorsal fins with 3-4 orange or red bars; anal and pelvic fin pale. Upper lobe of the caudal fin with 5-6 orange-black bars, lower lobe plain yellow with dark margin. Dorsal spines: 13-13; soft rays: 9-9; anal spines: 0-0; soft rays: 7-7; L_{max1} = 20 cm TL; L_{max2} = n.a.; L_{max3} = 20.0 cm FL (Fig. 84A). See Fig. 84B and Table 46 for length-weight relationship.

Occurs in the Indo-West Pacific from the east coast of Africa to Southeast Asia, the Indonesian Archipelago (Fig. 85) and the northern coasts of Australia; also reported from New Caledonia. Recently invaded the eastern Mediterranean from the Red Sea through the Suez Canal.

Found in coastal waters with a muddy substrate at depths ranging from 30 to 120 m (Fig. 86).

References: 393, 1263, 1449, 1486, 1975, 2029, 2178, 2795, 2857, 3397, 4789, 5213, 5381, 5385, 5450, 5525, 5756, 6306, 6328, 6567

Table 46. Length-weight (g/[FL;cm]) relationship of goldband goatfish, *Upeneus moluccensis*, in Indonesia.
[Tabel 46. Hubungan panjang-berat (g/[FL;cm]) ikan bijinangka, Upeneus moluccensis, *di Indonesia.]*

Parameter	Estimate
a	0.0451
s.e.(a)	0.0275
b	2.6364
s.e.(b)	0.2400
r^2	0.9631

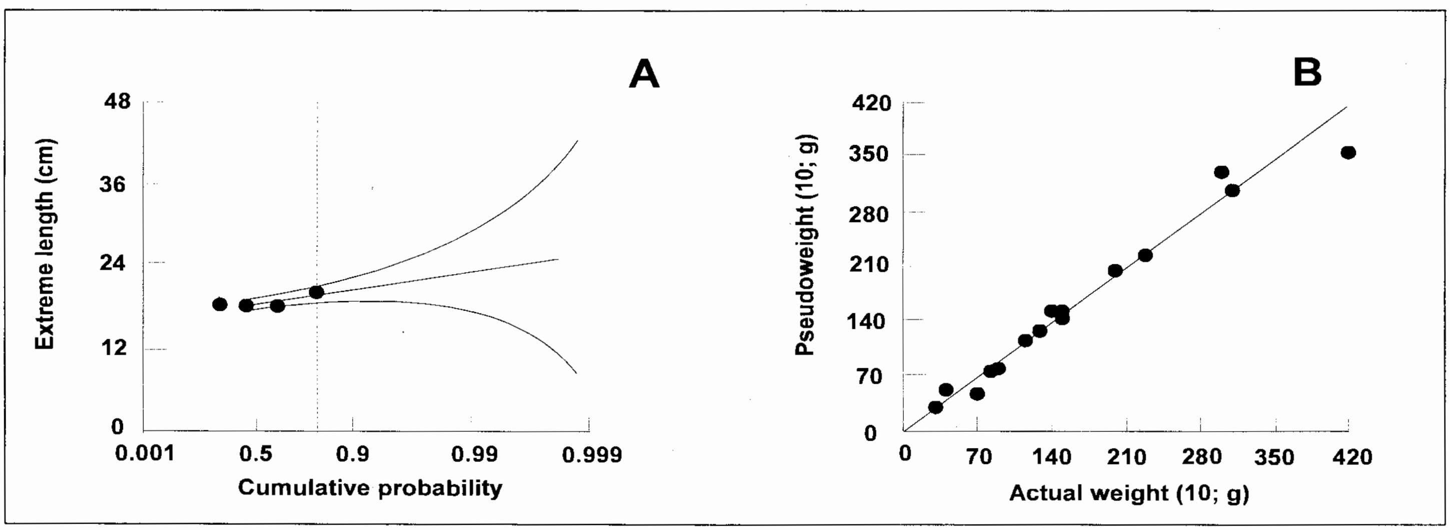

Fig. 84. (A) Extreme value plot for goldband goatfish, *Upeneus moluccensis*, in Indonesia based on data from *R/Vs Jurong* and *Dr. Fridtjof Nansen* showing maxima of 4 length-frequency samples, and estimate of L_{max3} = 20.0 ± 1.1 cm FL. (B) Predicted *vs.* observed weights (in g wet weight) of 15 length-frequency samples of goldband goatfish, *Upeneus moluccensis*, from Western Indonesia based on data from *R/Vs Jurong, Dr. Fridtjof Nansen* and *Bawal Putih 2* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 46).
[Gambar 84. (A) Gambaran nilai ekstrim ikan bijinangka, Upeneus moluccensis, *di Indonesia berdasarkan data dari kapal-kapal penelitian* Jurong *dan* Dr. Fridtjof Nansen *yang menunjukkan nilai maksimum untuk 4 contoh frekuensi-panjang, dan angka perkiraan* L_{max3} *= 20. ± 1.1 cm FL. (B). Berat prediksi terhadap berat observasi (dalam g berat basah) dari 15 contoh frekuensi-panjang ikan bijinangka,* Upeneus moluccensis, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Jurong, Dr. Fridtjof Nansen *dan* Bawal Putih 2 *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 46).*

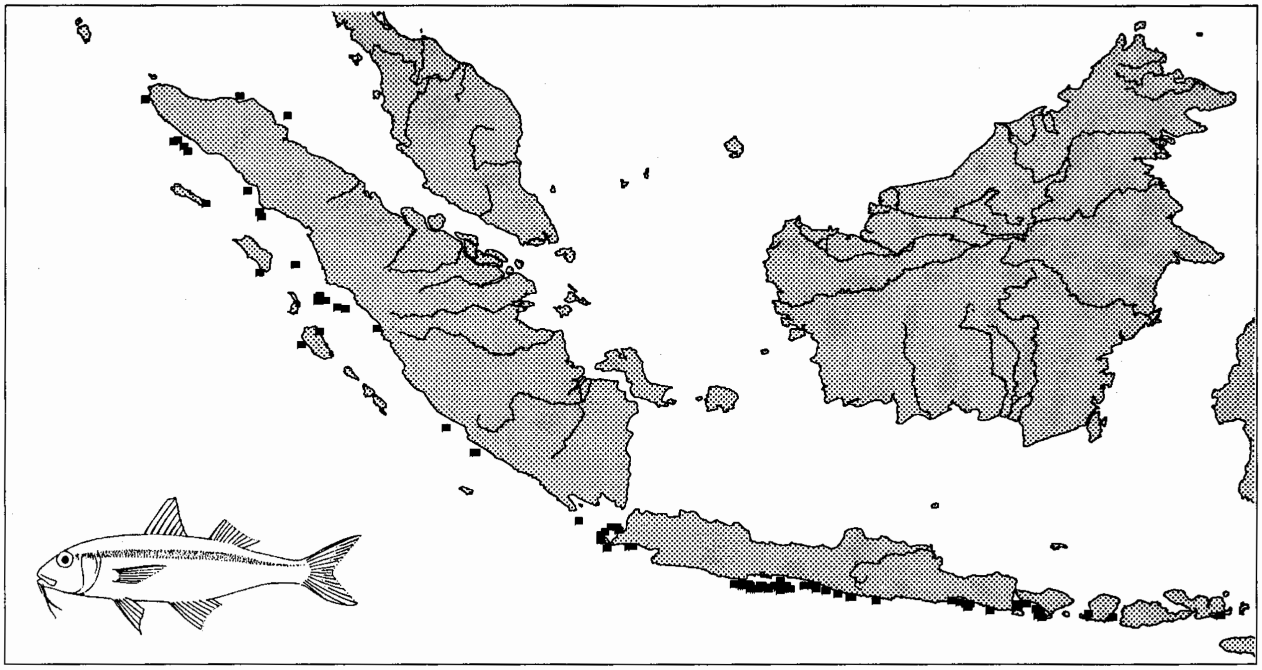

Fig. 85. Distribution of goldband goatfish, *Upeneus moluccensis*, based on records of the surveys of *R/Vs Jurong, Dr. Fridtjof Nansen* and *Bawal Putih 2.*

Gambar 85. Penyebaran ikan bijinangka, Upeneus moluccensis, *berdasarkan laporan survei kapal-kapal penelitian* Jurong, Dr. Fridtjof Nansen *dan* Bawal Putih 2.

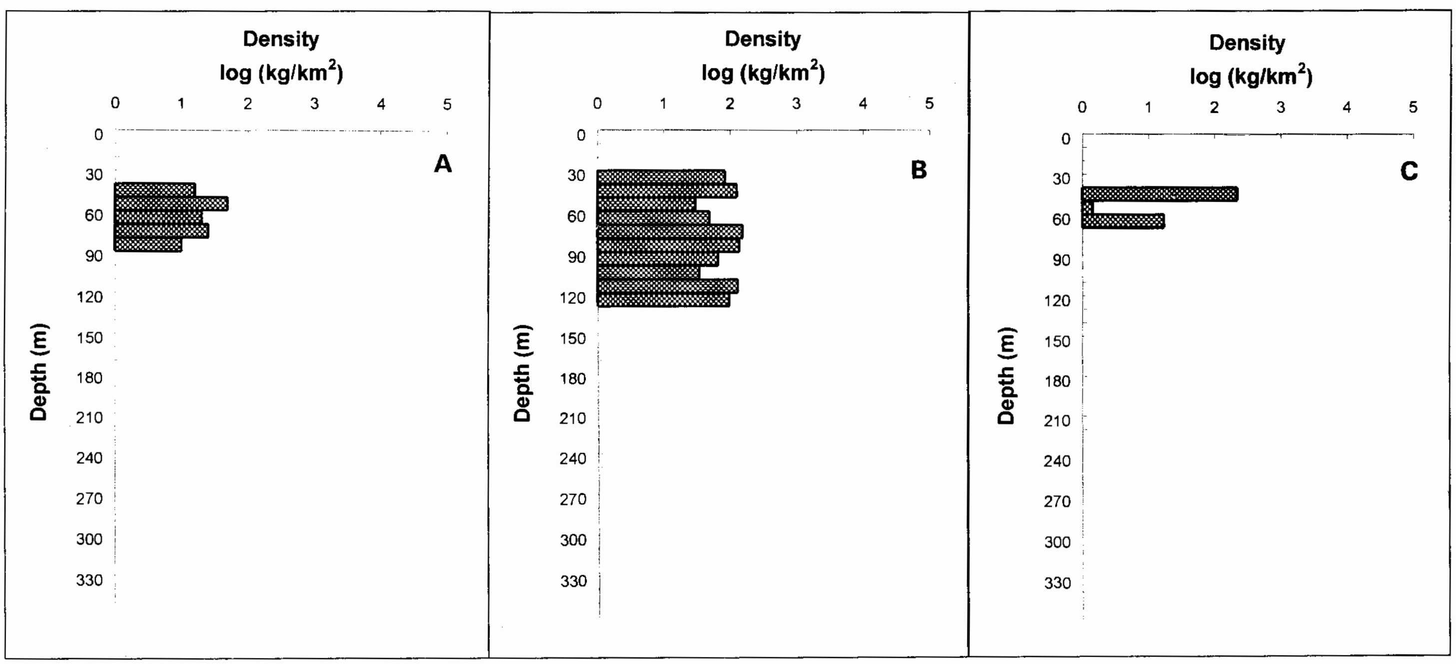

Fig. 86. Depth distribution of goldband goatfish, *Upeneus moluccensis*, based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen,* (B) *Jurong* and (C) *Bawal Putih 2.*

[Gambar 86. Penyebaran kedalaman ikan bijinangka, Upeneus moluccensis, *berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen, *(B)* Jurong *dan (C)* Bawal Putih 2.*]*

Upeneus sulphureus (Cuvier, 1829)

Sulphur goatfish (English); Kunir (Indonesian); Kakunir, Kunir, Kuniran (Java); Bidji nangka (West Java, Jakarta).

Medium-sized fish of moderately elongate bodies. Head small; mouth small and slightly oblique; a pair of barbels under the chin. Dorsal fins with 2 to 3 olive bars, and black or dark brown tips; anal, pelvic and pectoral fins pale; caudal fin plain dull yellow, its hind margin dusky, its lower lobe tipped white. Two orange-yellow bands extend from the head to the caudal peduncle. Dorsal spines: 8-8; soft rays: 8-8; anal spines: 1-1; soft rays: 7-7. L_{max1} = 23 cm; L_{max2} = n.a.; L_{max3} = 23 cm TL (Fig. 87A). See Fig. 87B and Table 47 for length-weight relationship.

From East Africa to Southeast Asia; through Indonesia (Fig. 88); northward to the coast of China and southward to the northern coasts of Australia; also reported from New Caledonia.

Forms schools in coastal waters. Depth range: 10-90 m (Fig. 89). Table 48 presents four sets of growth parameters from Indonesia.

References: 393, 1263, 1314, 1379, 1392, 1435, 1449, 1474, 1486, 1966, 2029, 2110, 2178, 2857, 2871, 2926, 3470, 4749, 4789, 5213, 5381, 5405, 5450, 5525, 5736, 5756, 6292, 6365, 6567

Table 47. Length-weight (g/[TL;cm]) relationship of sulphur goatfish, *Upeneus sulphureus*, in Indonesia.
[Tabel 47. Hubungan panjang-berat (g/[TL;cm]) ikan kunir, Upeneus sulphureus, *di Indonesia.]*

Parameter	Estimate A	Estimate B
a	0.009	0.0081
s.e.(a)	n.a.	0.0027
b	3.193	3.2134
s.e.(b)	n.a.	0.1272
r^2	n.a.	0.9782

A. Java (north coast) (Ref. 1379)
B. This study

Table 48. Growth parameters of sulphur goatfish, *Upeneus sulphureus*.
[Tabel 48. Parameter pertumbuhan ikan kunir, Upeneus sulphureus.*]*

Parameter	A	B	C	D
L_∞ (TL, cm)	15.8	16.5	17.5	19.9
K (year^{-1})	1.74	0.78	0.90	0.875

A. North Java Coast (Ref. 1435)
B. Java Sea (Central Java, 1978-79) (Ref. 1314)
C. Java Sea (Central Java, 1977-78) (Ref. 1314)
D. Java Sea (Ref. 1379)

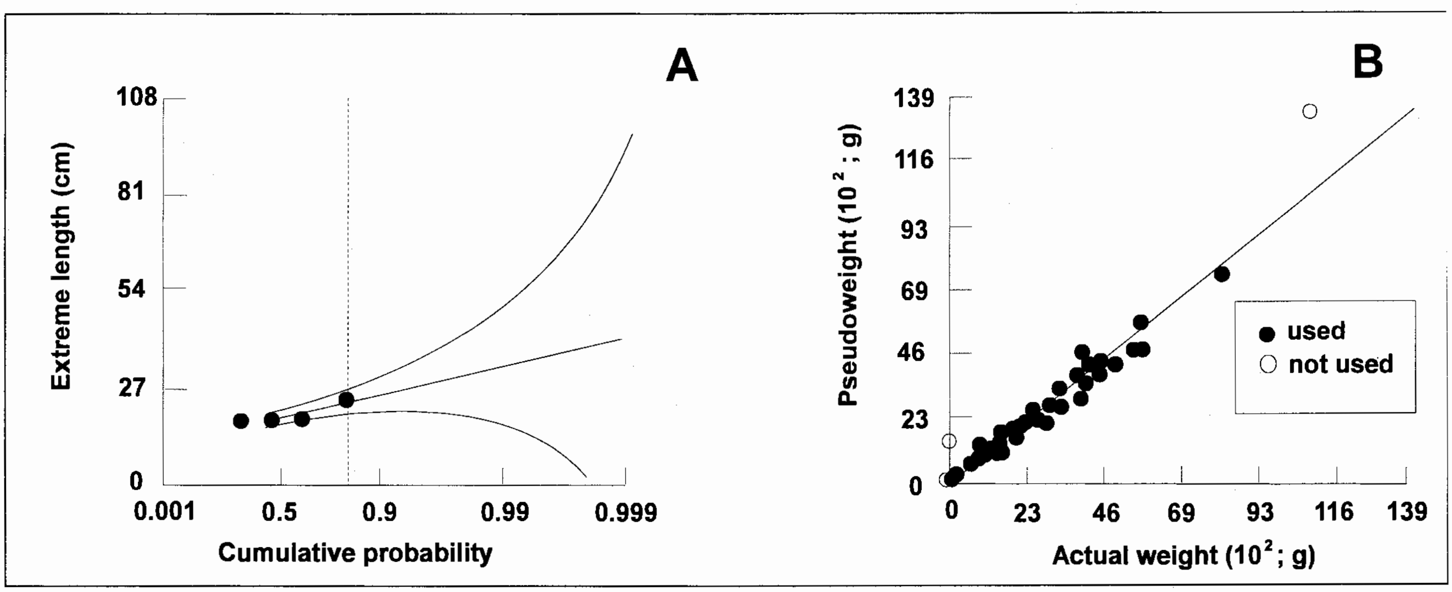

Fig. 87. (A) Extreme value plot for sulphur goatfish, *Upeneus sulphureus*, in Indonesia based on data from *R/Vs Mutiara 4* and *Bawal Putih 2* showing maxima of 4 length-frequency samples, and estimate of L_{max3} = 23 ± 3.8 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 44 length-frequency samples of sulphur goatfish, *Upeneus sulphureus*, from Western Indonesia based on data from *R/Vs Mutiara 4, Jurong, Dr. Fridtjof Nansen* and *Bawal Putih 2* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 47). Open dots represent outliers, not used for analysis.
[Gambar 87. (A) Gambaran nilai ekstrim ikan kunir, Upeneus sulphureus, *di Indonesia bedasarkan data dari kapal-kapal penelitian* Mutiara 4 *dan* Bawal Putih 2 *yang menunjukkan nilai maksimum untuk 4 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 23 ± 3.8. cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 44 contoh frekuensi-panjang ikan kunir,* Upeneus sulphureus, *dari Indonesia bagian barat berdasarkan data kapal-kapal penelitian* Mutiara 4, Jurong, Dr. Fridtjof Nansen *dan* Bawal Putih 2 *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 47). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

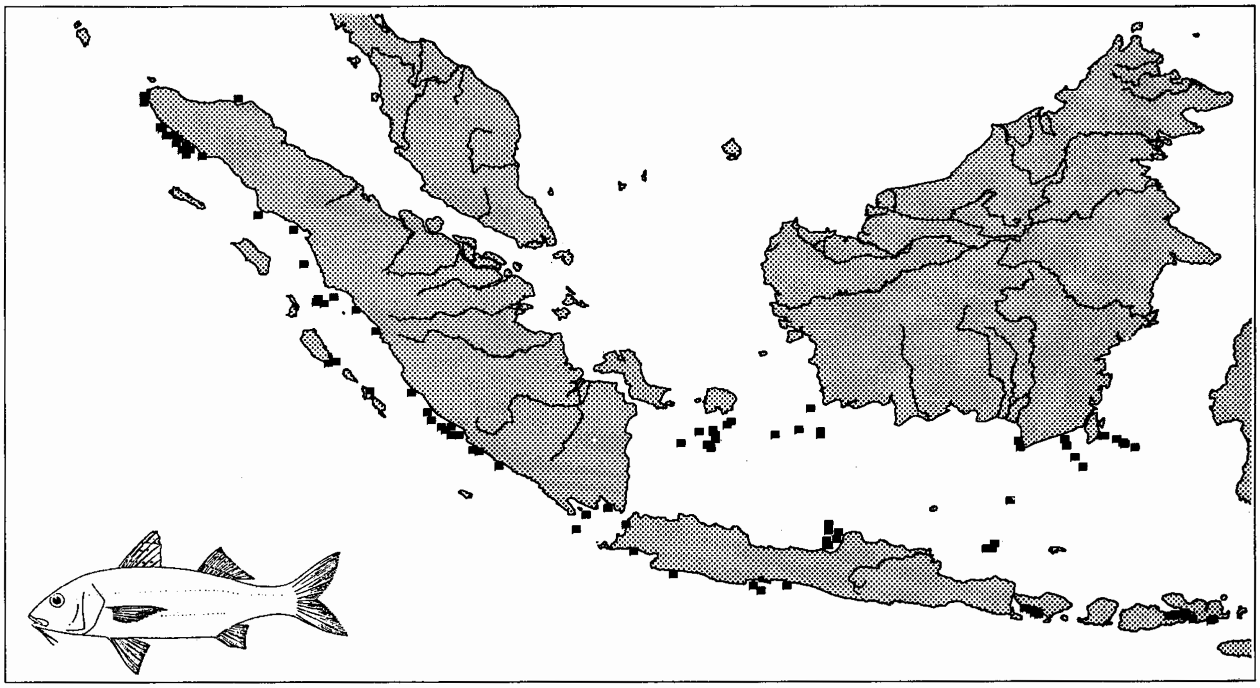

Fig. 88. Distribution of sulphur goatfish, *Upeneus sulphureus*, based on records of the surveys of *R/Vs Mutiara 4, Bawal Putih 2, Jurong* and *Dr. Fridtjof Nansen.*
[Gambar 88. Penyebaran ikan kunir, Upeneus sulphureus*, berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong *dan* Dr. Fridtjof Nansen.*]*

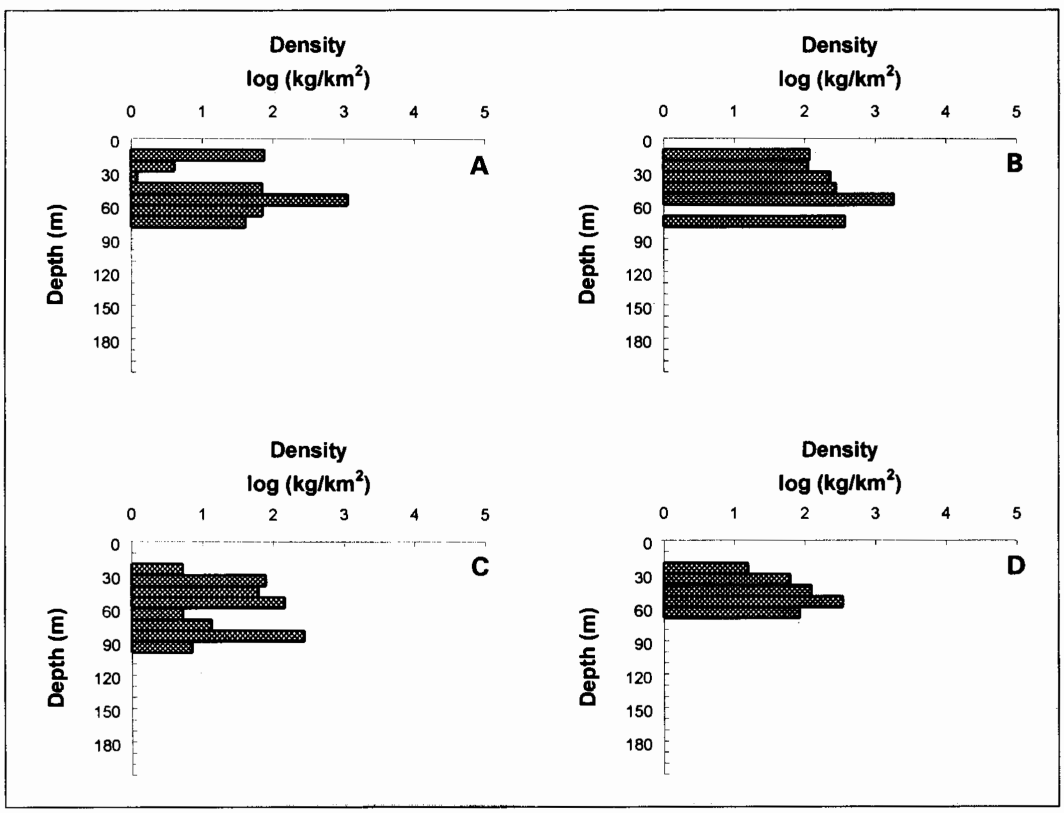

Fig. 89. Depth distribution of sulphur goatfish, *Upeneus sulphureus*, based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen,* (B) *Mutiara 4,* (C) *Jurong* and (D) *Bawal Putih 2.*
[Gambar 89. Penyebaran kedalaman ikan kunir, Upeneus sulphureus*, berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen, *(B)* Mutiara 4, *(C)* Jurong *dan (D)* Bawal Putih 2.*]*

Nemipterus thosaporni (Russell, 1991)

Palefin threadfin bream (English); Kurisi (Indonesian).

Lower edge of eye touching or just above a line from tip of snout to upper pectoral-fin base; lower edge of suborbital slightly emarginate. Dorsal fin origin about 3-7 scale rows from imaginary line projected upward from posterior edge of suborbital to dorsal profile. Pectoral and pelvic fins long, reaching to or just short of level of anal-fin origin. Closely resembles *N. bathybius*, but has no yellow stripe on either side of the ventral midline and the upper tip of the caudal fin not drawn into a distinct filament. Axillary scale present. Color: Upper part pinkish, silvery below. Dorsal spines: 10-10; soft rays: 9-9; anal spines: 3-3; soft rays: 7-7. L_{max1} = 21.5 cm SL; L_{max2} = 23 cm TL; L_{max3} = n.a. See Table 49 for length-weight relationship.

Widely distributed throughout the Western Pacific, notably in the Strait of Malacca, the Gulf of Thailand, the Sunda Islands, Indonesia (Fig. 90), and to southern Japan. This species has been previously misidentified as *N. marginatus* by most authors. Fig. 90 shows its distribution based on records of the *R/Vs Mutiara 4, Jurong* and *Dr. Fridtjof Nansen* surveys; Fig. 91 provides details on the distribution of *N. thosaporni* in the southern part of the South China Sea.

Found on sand or mud bottoms. Depth range: 10-80 m (Fig. 92). During that part of the *R/V Mutiara 4* survey which covered Area 5 in Pauly et al. (this vol.), i.e., the southern part of the South China Sea, D. Pauly and P. Martosubroto (Ref. 1158) measured a large number of nemipterids belonging to this species, which they thought was *Nemipterus marginatus*. This does not invalidate the results obtained by these two authors, and their main findings which are recalled here (see Box 4). Table 50 presents a set of growth parameters from Indonesia.

References: 171, 1066, 1139, 1158, 3207, 3810

Table 49. Length-weight (g/[TL;cm]) relationship of palefin threadfin bream, *Nemipterus thosaporni*, in Indonesia.
[Tabel 49. Hubungan panjang-berat (g/[TL;cm]) ikan kurisi, Nemipterus thosaporni, *di Indonesia.]*

Parameter	Estimate*
a	0.0135
b	3.02
r	0.999

*West Kalimantan (Ref. 1158)

Table 50. Growth parameters of palefin threadfin bream, *Nemipterus thosaporni.*
[Tabel 50. Parameter pertumbuhan ikan kurisi, Nemipterus thosaporni.*]*

Parameter	A	B
L_∞ (TL, cm)	24.5	28.4
K (year^{-1})	0.420	0.363

A. Western Kalimantan (Ref. 1158)
B. Sarawak and Sabah (Northern Kalimantan) (Ref. 1139)

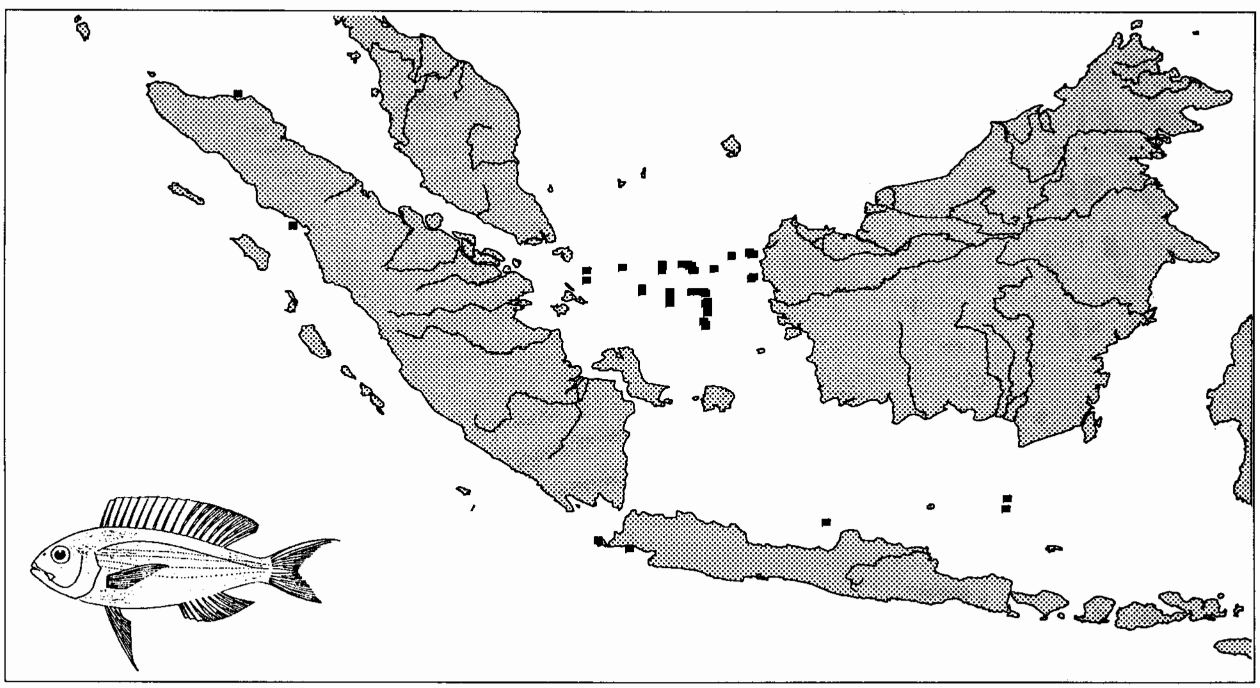

Fig. 90. Distribution of palefin threadfin bream, *Nemipterus thosaporni,* based on records of the surveys of *R/Vs Mutiara 4, Jurong* and *Dr. Fridtjof Nansen.*
[Gambar 90. Penyebaran ikan kurisi, Nemipterus thosaporni, *berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Jurong *dan* Dr. Fridtjof Nansen.*]*

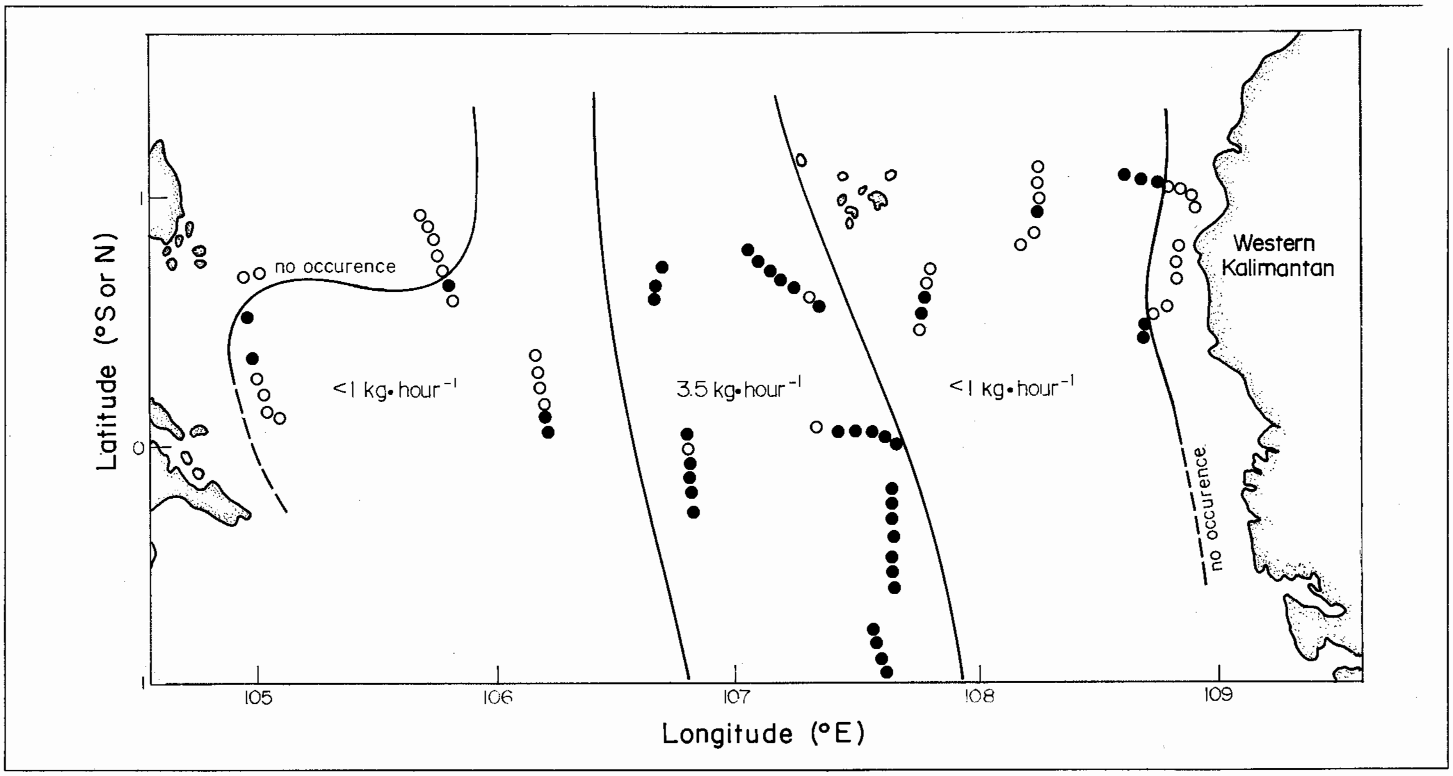

Fig. 91. Distribution and relative abundance of palefin threadfin bream, *Nemipterus thosaporni*, in the southern part of the South China Sea from 9 August to 29 September 1975. See Pauly et al. (this vol.) for details on this survey.
[Gambar 91. Penyebaran dan kelimpahan relatif ikan kurisi, Nemipterus thosaporni, *di bagian selatan Laut Cina Selatan dari 9 Agustus hingga 29 September 1975. Lihat Pauly et al. (dalam buku ini) untuk rincian survei ini.]*

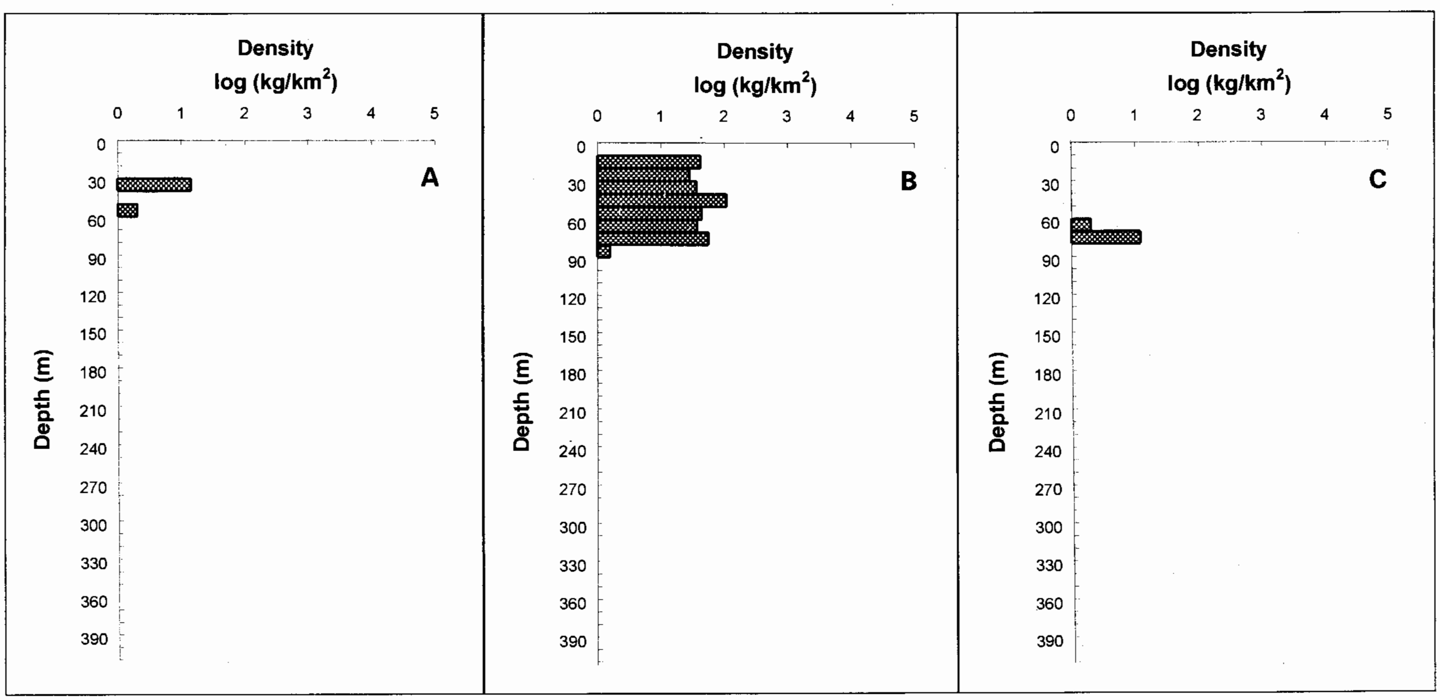

Fig. 92. Depth distribution of palefin threadfin bream, *Nemipterus thosaporni*, based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen,* (B) *Mutiara 4* and (C) *Jurong.*
[Gambar 92. Penyebaran kedalaman ikan kurisi, Nemipterus thosaporni, *berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen, *(B)* Mutiara 4 *dan (C)* Jurong.*]*

Box. 4. A case study of *Nemipterus thosaporni* a.k.a *N. marginatus*.
[Boks 4. Suatu studi kasus dari Nemipterus thosaporni, *yang dikenal juga dengan nama* N. marginatus.*]*

Purwito Martosubroto and I measured, from 6 August to 29 September 1975 (Ref. 1158) the 3,283 specimens of *N. thosaporni* (which we called *N. marginatus*) in the table below during a survey off Western Kalimantan (see Fig. 91).

Summary of length-frequency data on *Nemipterus thosaporni* from Western Kalimantan (= 3,283).

Lower limit of class (TL; cm)	N*	Lower limit of class (TL; cm)	N*
7.5	1	15.5	172
8.0	3	16.0	140
8.5	9	16.5	133
9.0	16	17.0	102
9.5	40	17.5	79
10.0	55	18.0	82
10.5	100	18.5	78
11.0	122	19.0	59
11.5	157	19.5	39
12.0	200	20.0	24
12.5	218	20.5	12
13.0	211	21.5	13
13.5	287	21.5	8
14.0	356	22.0	2
14.5	334	22.5	3
15.0	226	23.0	2

* Sum of 44 samples: Stations 59-147: see Fig. 4 in Pauly et al. (this vol.).

In the absence of computers, we used the then popular, graphical "Cassie method" (Ref. 9564) to split our cumulative samples into three normally distributed components, to which we assigned relative ages, which were then used to estimate von Bertalanffy growth parameters that compared well with previous estimate from Northern Kalimantan (Table 50). These growth parameters, complemented with a length-weight relationship (Table 49), and an estimate of M - estimated from the size distribution in the then unexploited stock - allowed computation of yield-per-recruit curves.

This entire procedure - although involving no development of new methodology - was exemplary in that it illustrated how a wide range of analytic techniques could be applied to data obtained during a fairly standard trawl survey, and a more or less complete "assessment" thus being performed using data then generally not perceived as being sufficient for such purpose.

Although it has been cited perhaps 20 times to date, this work is now rather well known among fisheries scientists in the tropics because it formed the base of a "case study", taught in the 1980s by Dr. Erik Ursin, of the roving FAO/DANIDA Training Course in Tropical Fish Stock Assessment, and consisting of the following elements:

i) evaluation of the work's methodology, based on copies of all paper cited in its "Methods" section;

ii) evaluation of the "Results" section, based on recomputation of all estimates, and re-evaluation of all assumptions (explicit and implicit); and

iii) evaluation of the "Discussion" section, through comparison with similar results in contemporary contributions (e.g., Ref. 1066), and later advances.

The paper survived this rather stringent test of its replicability, and the fish was thus allowed to migrate, via my textbook of 1984 (Ref. 4715) into the text that emerged from the above-mentioned training course (Ref. 9566).

I wish we had written more such papers.

Daniel Pauly
ICLARM
and
Fisheries Centre, UBC

Priacanthus macracanthus (Cuvier 1829)

Red bigeye (English); Swanggi (Indonesian); Swanggi (Javanese).

Medium-sized fish of moderately deep body. The eyes large; the mouth oblique, with the lower jaw projecting upwards. The body tapers very slightly to beneath the middle of the soft portion of the dorsal fin, then abruptly to the peduncle. This species is distinguished from *Priacanthus fitchi* by the presence of numerous rusty brown to yellowish spots in the membranes of the dorsal and anal fins, and its less tapered body. Dorsal spines: 10-10; soft rays: 12-14; anal spines: 3-3; soft rays: 13-14. L_{max1} = 29 cm SL; L_{max2} = n.a.; L_{max3} = 25.2 cm TL (Fig. 93A). See Fig. 93B and Table 51 for length-weight relationship.

East Indo-West Pacific: from southern Japan in the north to Western Indonesia (Fig. 94) and Australia in the south.

Occurs in inshore and offshore reefs, apparently forms aggregations in open bottom areas. Depth range: 20-350 m (Fig. 95). Table 52 presents 2 sets of growth parameters from Indonesia.

References: 559, 1263, 1314, 1449, 2857, 3132, 3414, 4539, 4885, 5381, 5736, 5756

Table 51. Length-weight (g/[TL;cm]) relationship of red bigeye, *Priacanthus macracanthus,* in Indonesia.
Tabel 51. Hubungan panjang-berat (g/[TL;cm]) ikan swanggi, Priacanthus macracanthus, *di Indonesia.*

Parameter	Estimate
a	0.0163
s.e.(a)	0.0072
b	2.9914
s.e.(b)	0.1648
r^2	0.9543

Table 52. Growth parameters of red bigeye, *Priacanthus macracanthus.*
Tabel 52. Parameter pertumbuhan ikan swanggi, Priacanthus macracanthus.

Parameter	A	B
L_∞ (TL, cm)	23	23.8
K (year^{-1})	1.15	1.30

A. Java Sea (Central Java, 1978-79) (Ref. 1314)
B. Java Sea (Central Java, 1977-78) (Ref. 1314)

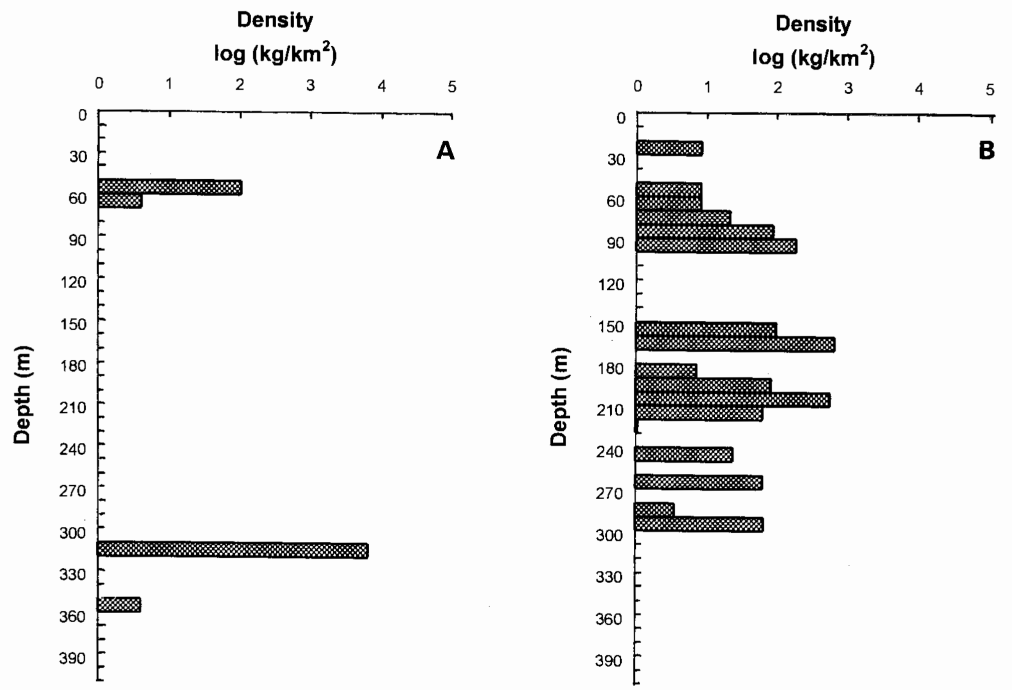

Fig. 95. Depth distribution of red bigeye, *Priacanthus macracanthus*, based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen* and (B) *Jurong*.
[Gambar 95. Penyebaran kedalaman ikan swanggi, Priacanthus macracanthus, *berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen *dan (B)* Jurong.*]*

Rastrelliger kanagurta (Cuvier, 1816)

Indian mackerel (English); Kembung lelaki (Indonesian); Banjar, Kembung lelaki (West Java, Jakarta); Gombong (Central Java); Bulus lake, Saängsa (Madura); Banjara (South Sulawesi, Makassar); Botto-botto (South Sulawesi, Bugis); Banjar (South Sulawesi, Badjo).

Head longer than body depth. Maxilla partly concealed, covered by lacrimal bone but extending to about hind margin of eye. Bristles on longest gillraker 105 on one side in specimens of 12.7 cm, 140 in 16 cm, and 160 in 19 cm fork length specimens. A black spot on body near lower margin of pectoral fin. Interpelvic process small and single. Swimbladder present. Anal spine rudimentary. Dorsal spines: 8-11; soft rays: 12-12; anal spines: 0-0; soft rays: 12-12. L_{max1} = 36 cm TL; L_{max2} = 26 cm; L_{max3} = 26.8 cm TL (Fig. 96A). See Fig. 96B and Table 53 for length-weight relationship.

Indo-West Pacific: from South Africa and the Seychelles in the east to the Red Sea, and Southeast Asia; Indonesia (Fig. 97); north to the Ryukyu Islands, China. Southeast to Northern Australia, Melanesia, Micronesia, Samoa. Entered the eastern Mediterranean Sea through the Suez Canal.

Form schools in coastal waters, bays and deep lagoons, usually in plankton-rich waters. Depth range: 20-90 m (Fig. 98). Feeds on phytoplankton (diatoms) and small zooplankton (cladocerans, ostracods, larval polychaetes, etc.). Adult individuals feed on macroplankton (larval shrimps and fish). Table 54 presents six sets of growth parameters from Indonesia.

References: 168, 171, 312, 762, 786, 821, 1139, 1195, 1196, 1197, 1198, 1263, 1314, 1389, 1392, 1447, 1449, 1462, 1463, 1464, 1465, 1466, 1467, 1485, 1488, 1531, 1602, 1687, 1751, 1836, 2178, 3557, 3626, 3621, 3579, 3669, 3670, 3678, 4546, 4547, 4593, 4749, 4789, 4838, 5213, 5284, 5385, 5450, 5756

Table 53. Length-weight (g/[TL;cm]) relationship of Indian mackerel, *Rastrelliger kanagurta*, in Indonesia.
[Tabel 53. Hubungan panjang-berat (g/[TL;cm]) ikan kembung lelaki, Rastrelliger kanagurta, *di Indonesia.]*

Parameter	Estimates A	B	C	D	E
a	0.0039	0.0061	0.0022	0.0014	0.0061
s.e. (a)	n.a.	n.a.	n.a.	n.a.	0.0027
b	3.1900	3.1910	3.3300	3.3770	3.1743
s.e. (b)	n.a.	n.a.	n.a.	n.a.	0.1437
r^2	n.a.	n.a.	n.a.	n.a.	0.9909

A. Indonesia, Java Sea (Ref. 1463)
B. Indonesia, Java Sea (Ref. 1196)
C. Indonesia, Andaman Islands (Ref. 1463)
D. Indonesia, Malacca Strait (Ref. 1389)
E. This study

Table 54. Growth parameters of Indian mackerel, *Rastrelliger kanagurta*.
Tabel 54. Parameter pertumbuhan ikan kembung lelaki, Rastrelliger kanagurta.

Parameter	A	B	C	D	E	F
L_∞ (TL, cm)	23.9	25.7	25.8	26.5	28.5	28.7
K ($year^{-1}$)	2.76	1.625	1.63	0.80	0.90	0.78

A. Indonesia, Java Sea (Ref. 1196)
B. Indonesia, Java Sea (Ref. 1447)
C. Indonesia, Java Sea (Pekalongan, 1982-83) (Ref. 1314)
D. Indonesia, Asahan, Sumatra (Ref. 1467)
E. Indonesia, Banda Aceh (Ref. 4547)
F. Indonesia, Strait of Malacca (1984-86) (Ref. 1389)

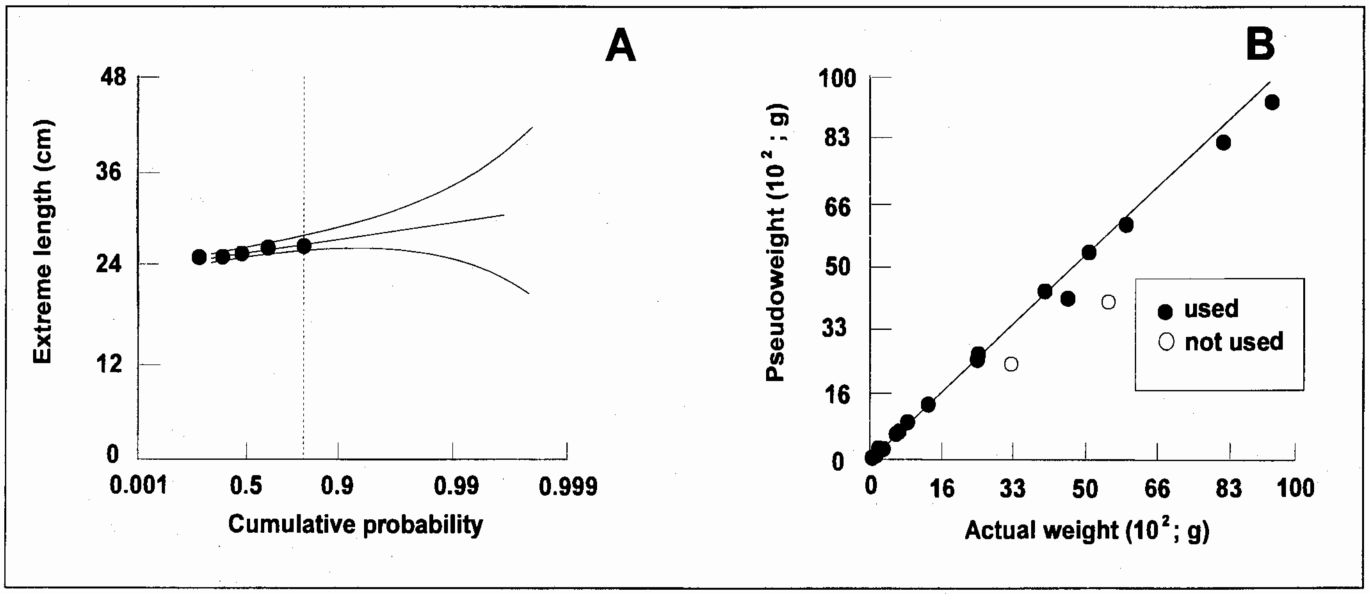

Fig. 96. (A) Extreme value plot for Indian mackerel, *Rastrelliger kanagurta*, in Indonesia based on data from *R/Vs Mutiara 4* and *Jurong* showing maxima of 5 length-frequency samples, and estimate of L_{max3} = 26.8 ± 0.85 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 16 length-frequency samples of Indian mackerel, *Rastrelliger kanagurta*, from Western Indonesia based on data from *R/Vs Mutiara 4, Bawal Putih 2, Jurong* and *Dr. Fridtjof Nansen* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 53). Open dots represent outliers, not used for analysis.
[Gambar 96. (A) Gambaran nilai ekstrim ikan kembung lelaki, Rastrelliger kanagurta, *di Indonesia berdasarkan data dari kapal-kapal penelitian* Mutiara 4 *dan* Jurong *yang menunjukkan nilai maksimum 5 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 26.8 ± 0.85 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 16 contoh frekuensi-panjang ikan kembung lelaki,* Rastrelliger kanagurta, *dari Indonesia bagian barat berdasarkan data kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong *dan* Dr. Fridtjof Nansen *sebagai luaran perangkat lunak ABee (lihat Box 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 53). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

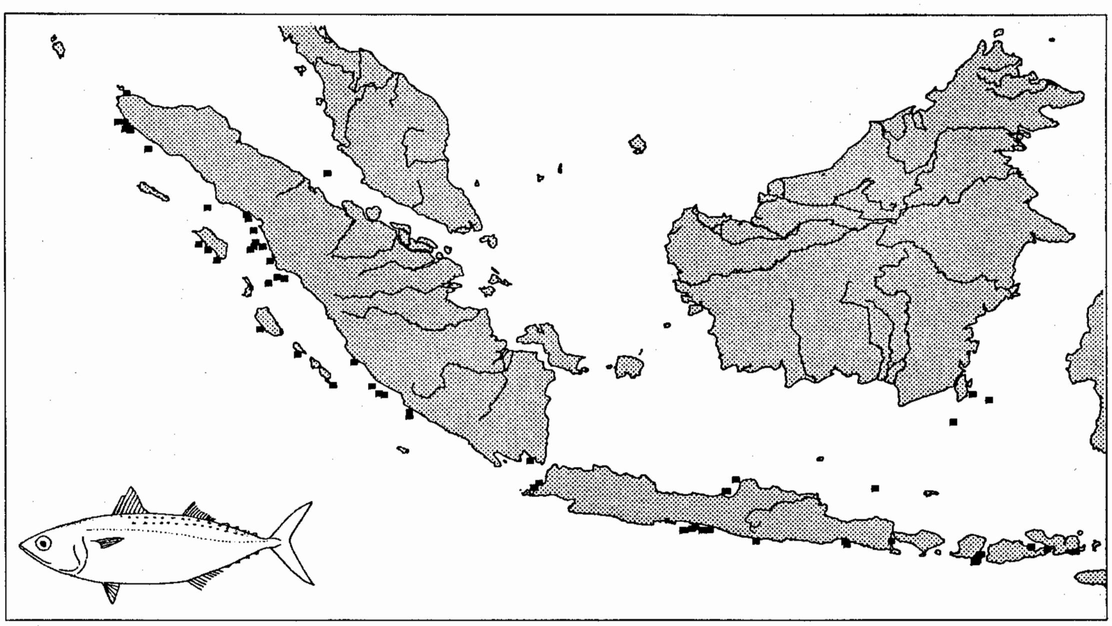

Fig. 97. Distribution of Indian mackerel, *Rastrelliger kanagurta*, based on records of the surveys of *R/Vs Mutiara 4, Bawal Putih* 2, *Jurong* and *Dr. Fridtjof Nansen.*
[Gambar 97. Penyebaran ikan kembung lelaki, Rastrelliger kanagurta, *berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong *dan* Dr. Fridtjof Nansen.*]*

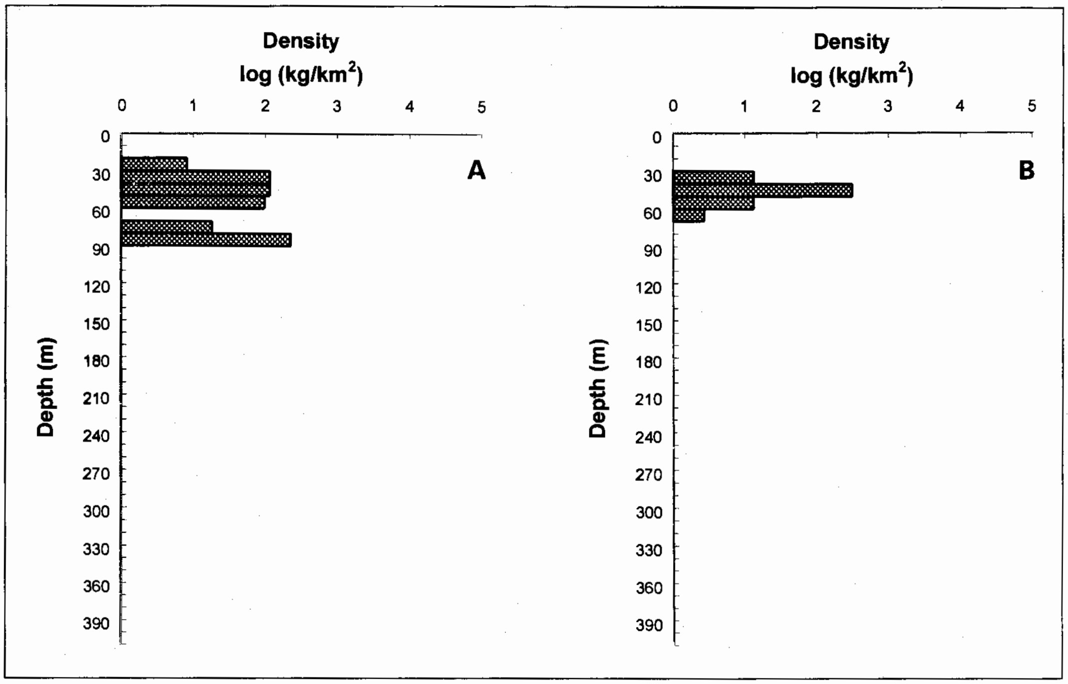

Fig. 98. Depth distribution of Indian mackerel, Rastrelliger kanagurta, based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen* and (B) *Bawal Putih 2.*
[Gambar 98. Penyebaran kedalaman ikan kembung lelaki, Rastrelliger kanagurta, *berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen *dan (B)* Bawal Putih 2.*]*

Scomberomorus commerson (Lacepède, 1800)

Narrow-barred Spanish mackerel (English); Tjalong (Indonesian); Tengiri (West Java, Jakarta); Langung, Tengere, Tjalong, Tjangetjang (Madura).

Interpelvic process small and bifid. Swimbladder absent. Lateral line abruptly bent downward below end of second dorsal fin. Intestine with 2 folds and 3 limbs. Vertical bars on trunk sometimes break up into spots ventrally which number 40-50 in adults, and less than 20 in juveniles (which have jet black anterior first dorsal fin). Dorsal spines: 15-18; soft rays: 15-20; anal spines: 0-0; soft rays: 16-21. L_{max1} = 220 cm FL; L_{max2} = n.a.; L_{max3} = 96.9 cm FL (Fig. 99A). See Fig. 99B and Table 55 for length-weight relationship.

Indo-West Pacific: from South Africa and the Red Sea

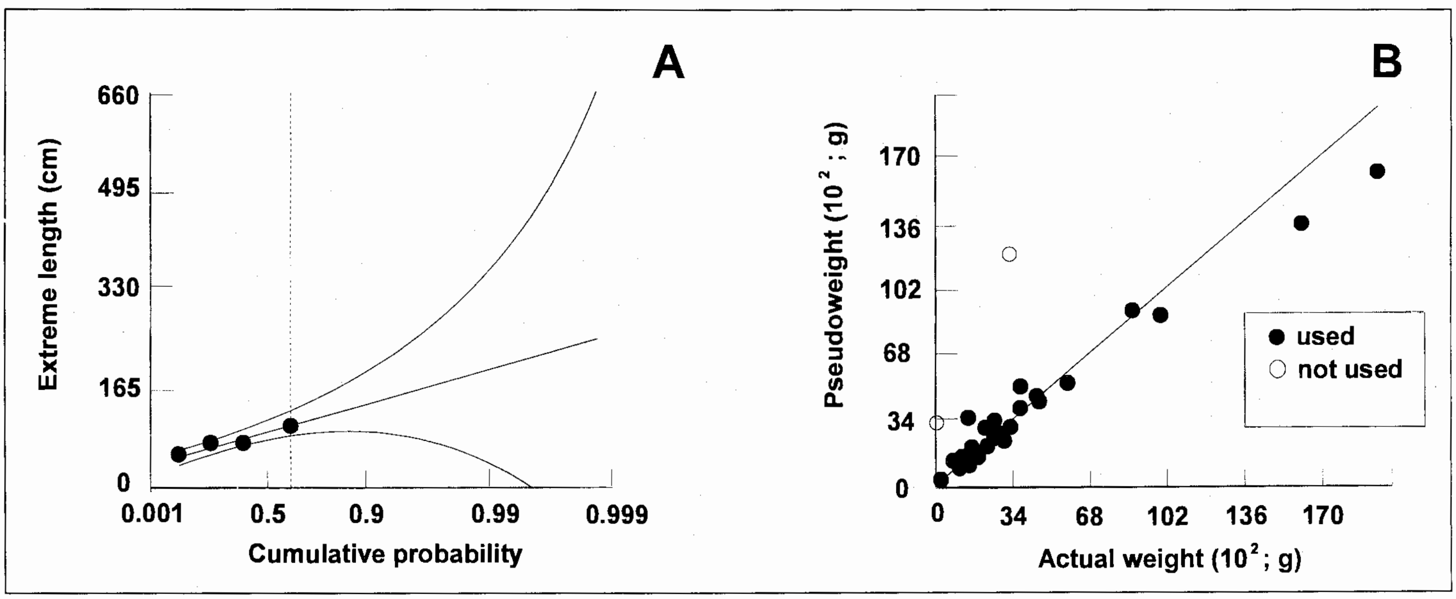

Fig. 99. (A) Extreme value plot for narrow-barred Spanish mackerel, *Scomberomorus commerson*, in Indonesia based on data from *R/V Jurong* showing maxima of 4 length-frequency samples, and estimate of L_{max3} = 96.9 ± 26.2 cm FL. (B) Predicted *vs.* observed weights (in g wet weight) of 32 length-frequency samples of narrow-barred Spanish mackerel, *Scomberomorus commerson,* from Western Indonesia based on data from *R/Vs Mutiara 4* and *Jurong* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 55). Open dots represent outliers, not used for analysis.
[Gambar 99. (A) Gambaran nilai ekstrim ikan tenggiri papan, Scomberomorus commerson, *di Indonesia berdasarkan data dari kapal penelitian* Jurong *menunjukkan nilai maksimum dari 4 contoh frekuensi-panjang, dan angka perkiraan* L_{max3} *= 96.9 ± 26.2 cm FL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 32 contoh frekuensi panjang ikan tenggiri papan,* Scomberomorus commerson, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4 *dan* Jurong *sebagai luaran perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 55). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

through Southeast Asia, north to China and Japan and southward to Indonesia (Fig. 100) and Southeast Australia. A recent immigrant to the eastern Mediterranean Sea by way of the Suez Canal. Atlantic Ocean: reported only from St. Helena.

Found in small schools and known to undertake lengthy longshore migrations, but permanently resident populations also seem to exist. Depth range: 10-70 m (Fig. 101). Feeds primarily on small fish such as anchovies, clupeids, carangids, squids and penaeid shrimps.

References: 168, 171, 1139, 1263, 1375, 1391, 1415, 1416, 1470, 1498, 1602, 2325, 2682, 2857, 3383, 3557, 3626, 3678, 4332, 4588, 4699, 4883, 4905, 5213, 5284, 5288, 5385, 5450, 5515, 5736, 5756, 5765, 5766, 5970, 6026, 6323, 6365, 6783

Table 55. Length-weight (g/[FL;cm]) relationship of narrow-barred Spanish mackerel, *Scomberomorus commerson*, in Indonesia.
[Tabel 55. Hubungan panjang-berat (g/[FL;cm]) ikan tenggiri papan, Scomberomorus commerson, *di Indonesia.]*

Parameter	Estimate
a	0.0057
s.e. (a)	0.0046
b	3.1247
s.e. (b)	0.2094
r^2	0.9271

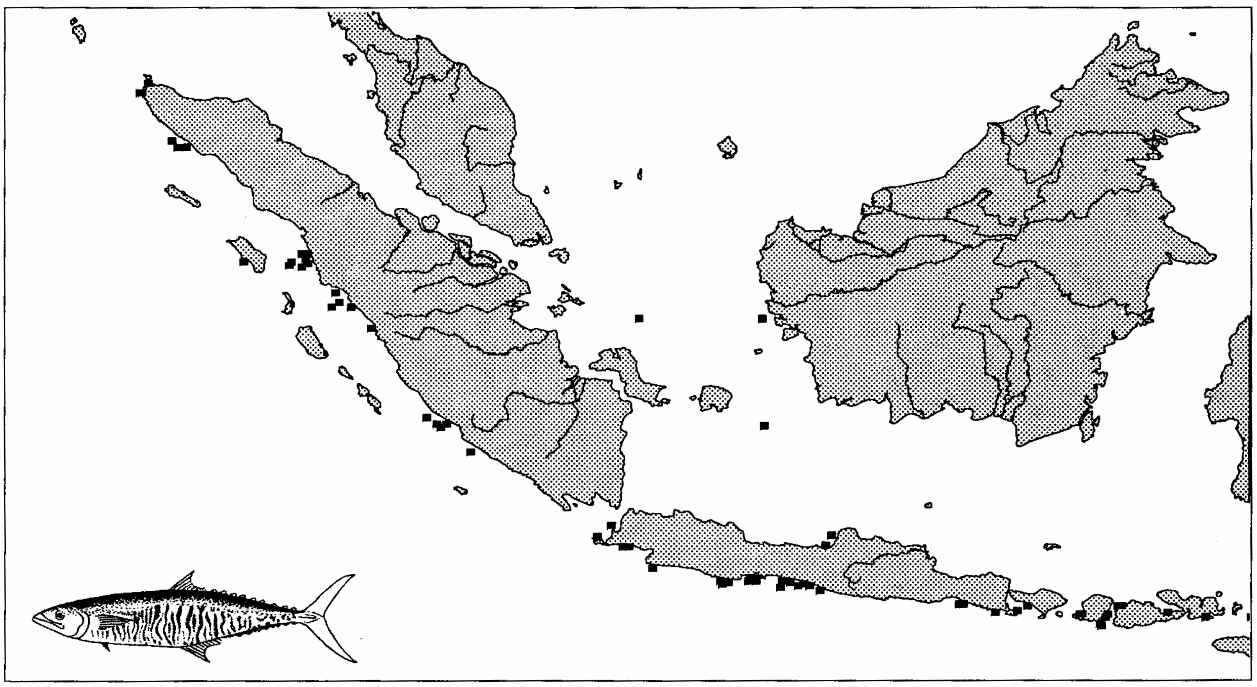

Fig. 100. Distribution of narrow-barred Spanish mackerel, *Scomberomorus commerson*, based on records of the surveys of *R/Vs Mutiara 4, Bawal Putih 2, Jurong* and *Dr. Fridtjof Nansen.*
[Gambar 100. Penyebaran ikan tenggiri papan, Scomberomorus commerson, *berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong *dan* Dr. Fridtjof Nansen.*]*

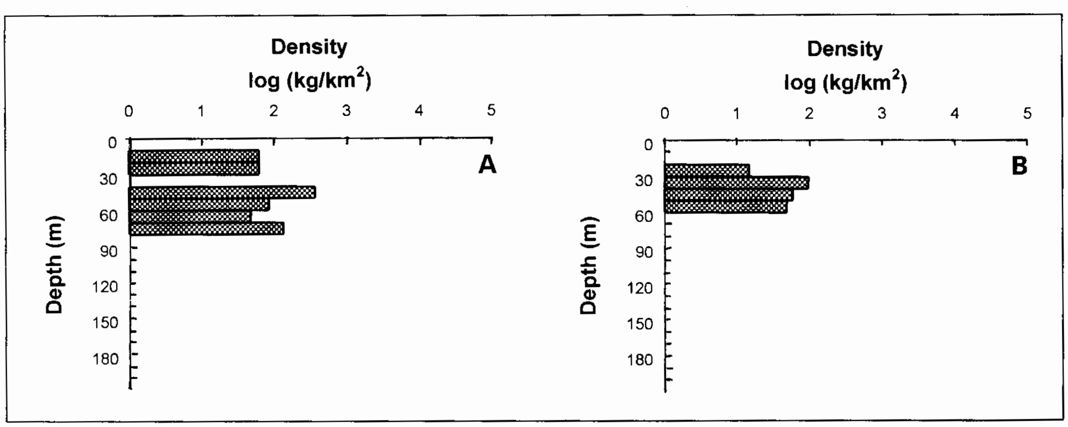

Fig. 101. Depth distribution of narrow-barred Spanish mackerel, *Scomberomorus commerson*, based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen* and (B) *Bawal Putih 2.*
[Gambar 101. Penyebaran kedalaman ikan tenggiri papan, Scomberomorus commerson, *berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen *dan (B)* Bawal Putih 2.*]*

Scomberomorus guttatus (Bloch & Schneider, 1801)

Indo-Pacific king mackerel (English); Tenggiri (Indonesian); Ajong-ajong, Usek-usek (Java); Tengiri (West Java, Jakarta); Langung, Tengere, Tjalong, Tjangetjang (Madura); Tengiri (South Borneo).

Interpelvic process small and bifid. Swimbladder absent. Body entirely covered with small scales. Lateral line with many auxiliary branches extending dorsally and ventrally in anterior third, curving down toward caudal peduncle. Intestine with 2 folds and 3 limbs. Sides silvery white with several rows of round dark brownish spots scattered in about three irregular rows along the lateral line. First dorsal fin membrane black. Dorsal spines: 15-18; soft rays: 18-24; anal spines: 0-0; soft rays: 19-23. L_{max1} = 76 cm FL; L_{max2} = n.a.; L_{max3} = 64.4 cm FL (Fig. 102A). See Fig. 102B and Table 56 for length-weight relationship.

Indo-West Pacific from the Persian Gulf, India and Sri Lanka to Southeast Asia, Indonesia (Fig. 103); north to Hong Kong and Wakasa Bay, Sea of Japan.

Depth range: 20-90 m (Fig. 104). A pelagic migratoryy fish inhabiting coastal waters; sometimes entering turbid estuarine waters, usually found in small schools. Feeds mainly on small schooling fishes (especially sardines and anchovies), squids and crustaceans.

References: 168, 171, 280, 298, 2682, 3383, 4515, 4588, 4883, 5515, 5285, 5736, 5756, 6313, 6365, 6567

Table 56. Length-weight (g/[FL;cm]) relationship of Indo-Pacific king mackerel, *Scomberomorus guttatus*, in Indonesia.
[Tabel 56. Hubungan panjang-berat (g/[FL;cm]) ikan tenggiri, Scomberomorus guttatus, *di Indonesia.]*

Parameter	Estimate
a	0.0096
s.e.	0.0053
b	3.0020
s.e.	0.1515
r^2	0.9777

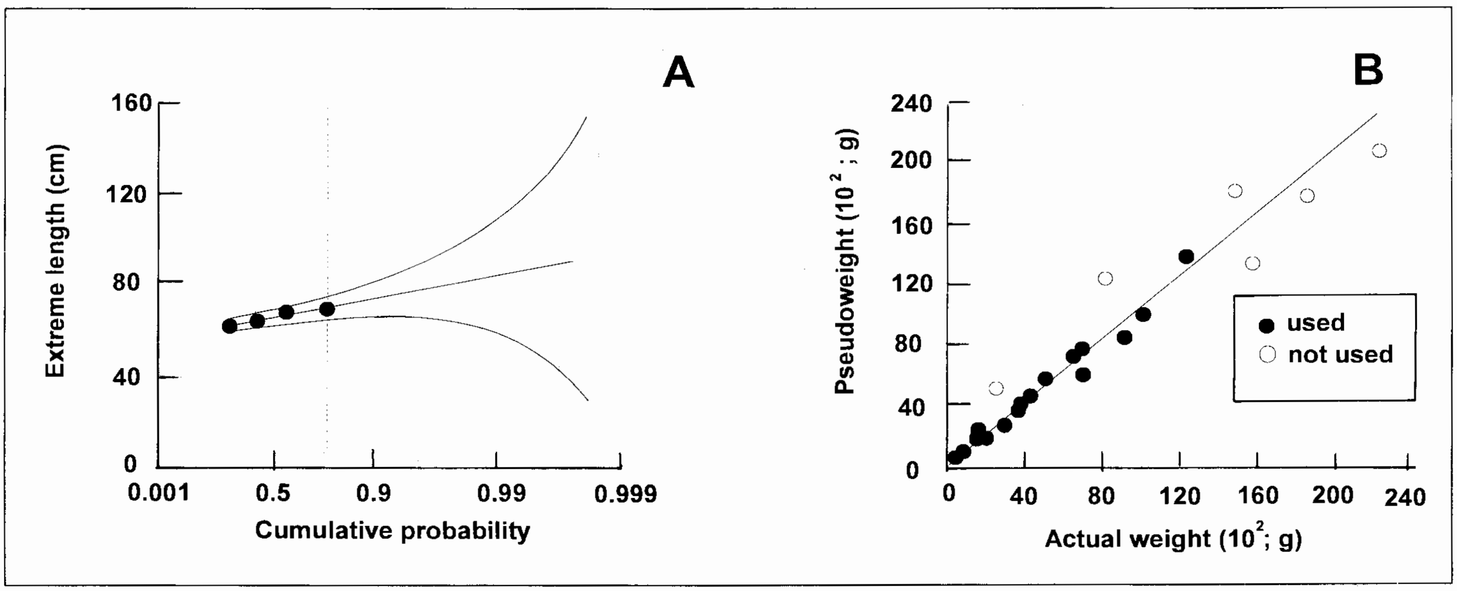

Fig. 102. (A) Extreme value plot for Indo-Pacific king mackerel, *Scomberomorus guttatus,* in Indonesia based on data from *R/Vs Mutiara 4, Bawal Putih 2* and *Dr. Fridtjof Nansen* showing maxima of 4 length-frequency samples, and estimate of L_{max3} = 64.4 ± 4.35 cm FL. (B) Predicted *vs.* observed weights (in g wet weight) of 16 length-frequency samples of Indo-Pacific king mackerel, *Scomberomorus guttatus,* from Western Indonesia based on data from *R/Vs Mutiara 4, Bawal Putih 2, Dr. Fridtjof Nansen* and *Jurong* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 56). Open dots represent outliers, not used for analysis.
[Gambar 102. (A) Gambaran nilai ekstrim ikan tenggiri, Scomberomorus guttatus, *di Indonesia berdasarkan data kapal-kapal penelitian* Mutiara 4, Bawal Putih 2 *dan* Dr. Fridtjof Nansen *menunjukkan nilai maksimum dari 4 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 64.4 ± 4.35 cm FL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 16 contoh frekuensi-panjang ikan tenggiri,* Scomberomorus guttatus, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Dr. Fridtjof Nansen *dan* Jurong *sebagai luaran perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 56). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

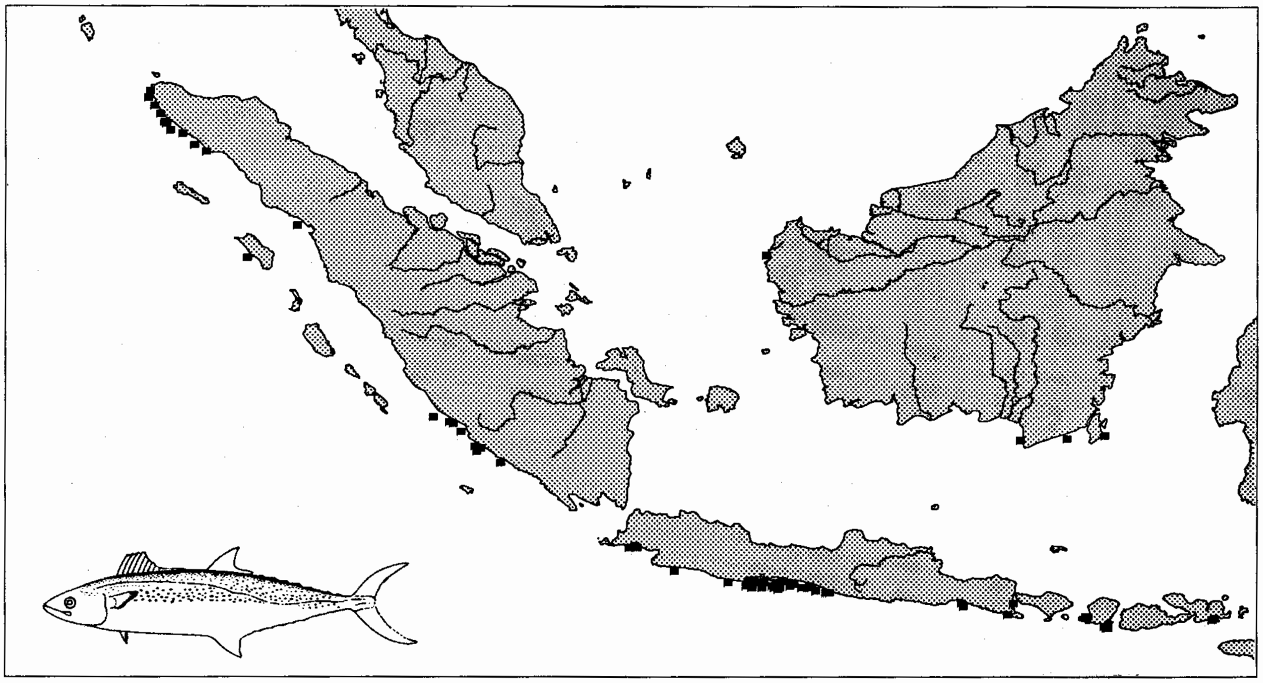

Fig. 103. Distribution of Indo-Pacific king mackerel, *Scomberomorus guttatus,* based on records of the surveys of *R/Vs Mutiara 4, Bawal Putih 2, Jurong* and *Dr. Fridtjof Nansen.*
[Gambar 103. Penyebaran ikan tenggiri, Scomberomorus guttatus, *berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong *dan* Dr. Fridtjof Nansen.*]*

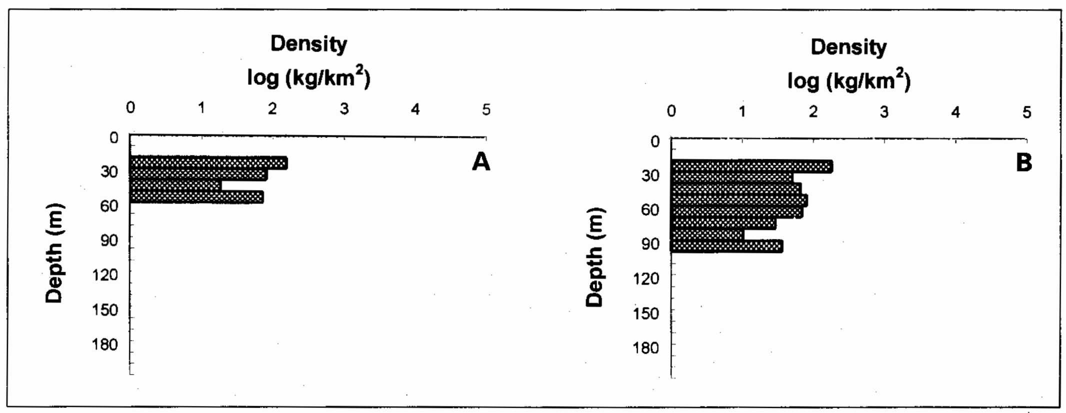

Fig. 104. Depth distribution of Indo-Pacific king mackerel, *Scomberomorus guttatus*, based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen* and (B) *Jurong.*
[Gambar 104. Penyebaran kedalaman ikan tenggiri, Scomberomorus guttatus, *berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen *dan (B)* Jurong.*]*

Sphyraena obtusata (Cuvier, 1829)

Obtuse barracuda (English); Tantjak (Indonesia); Alu-alu, Kutjul, Langsar (Java);Alu-alu (West Java, Jakarta); Kotjol, Tantjak (Madura).

Body elongate and subcylindrical with small cycloid scales; head long and pointed. Mouth large and horizontal, the tip of the lower jaw protruding; intermaxilla non-protractile. Preoperculum rectangular, with wide naked skin flap. First dorsal fin origin slightly before the pectoral fin tip, the first spine equal to the second. Pelvic fins well before the tip of the pectoral, closer to the anal than the tip of the lower jaw. Color is generally green above and silvery below. Dorsal spines: 6-6; soft rays: 9-9; anal spines: 2-2; soft rays: 9-9. L_{max1} = 55 cm; L_{max2} = n.a.; L_{max3} = 47.3 cm FL (Fig. 105A). See Fig. 105B and Table 57 for length-weight relationship.

Indo-Pacific Ocean: East Africa and Red Sea to Philippines and Indonesia (Fig. 106); from Samoa north to Ryukyus, south to Lord Howe Islands; Kapingamarangi and Marianas in Micronesia. Migrated to eastern Mediterranean from the Red Sea via the Suez Canal.

Inhabits bays and estuaries. Found in schools in seagrass beds and rocky reefs. Depth range: 20-120 (Fig. 107). Feeds mainly on fishes.

References: 560, 1365, 1602, 2857, 4752, 5213, 5381, 5385, 5450, 5525, 5579, 5736, 5756, 6328, 6365, 6567

Table 57. Length-weight (g/[FL;cm]) relationship of obtuse barracuda, *Sphyraena obtusata,* in Indonesia.
[Tabel 55. Hubungan panjang-berat (g/[FL;cm]) ikan alu-alu, Sphyraena obtusata, *di Indonesia.]*

Parameter	Estimate
a	0.0095
s.e.(a)	0.0031
b	2.8678
s.e.(b)	0.0977
r^2	0.9961

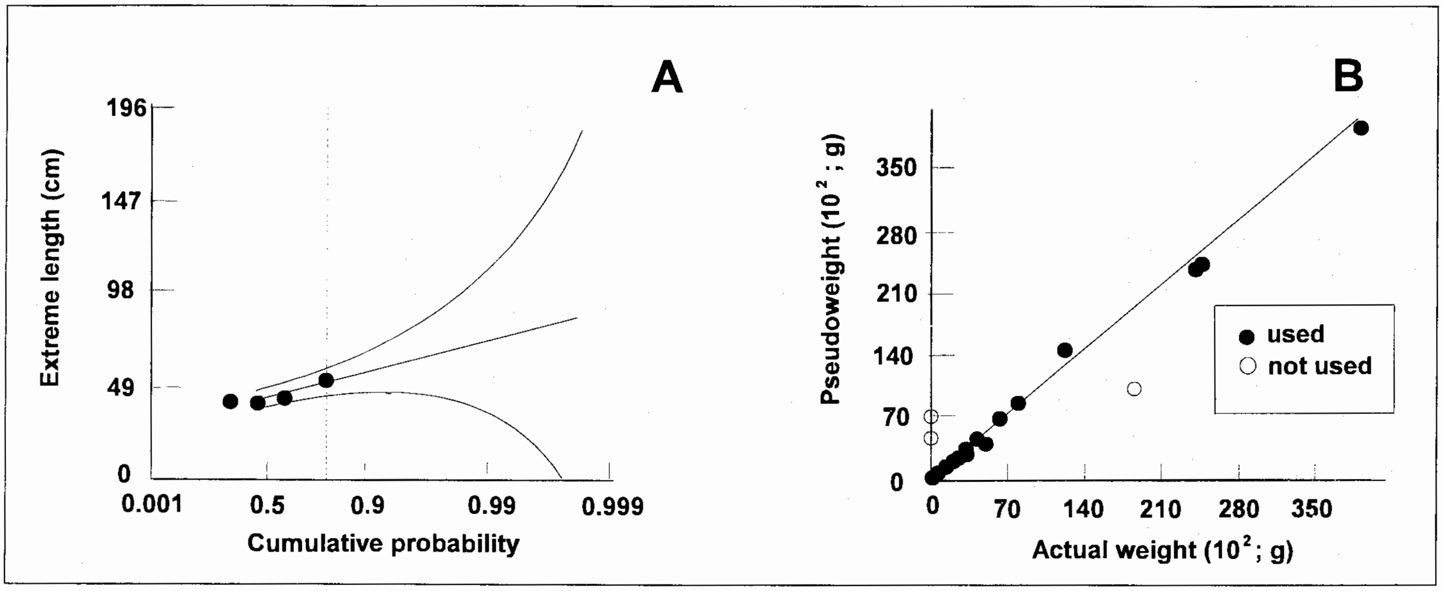

Fig. 105. (A) Extreme value plot for obtuse barracuda, *Sphyraena obtusata,* in Indonesia based on data from *R/V Jurong* showing maxima of 4 length-frequency samples, and estimate of L_{max3} = 47.3 ± 7.0 cm FL. (B) Predicted *vs.* observed weights (in g wet weight) of 19 length-frequency samples of obtuse barracuda, *Sphyraena obtusata,* from Western Indonesia based on data from *R/Vs Mutiara 4, Jurong* and *Dr. Fridtjof Nansen* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 57). Open dots represent outliers, not used for analysis. *[Gambar 105. (A) Gambaran nilai ekstrim ikan alu-alu,* Sphyraena obtusata; *di Indonesia berdasarkan data kapal penelitian* Jurong *menunjukkan nilai maksimum dari 4 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 47.3 ± 7.0 cm FL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 19 contoh frekuensi-panjang ikan alu-alu,* Sphyraena obtusata, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Jurong *dan* Dr. Fridtjof Nansen, *sebagai luaran perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 57). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

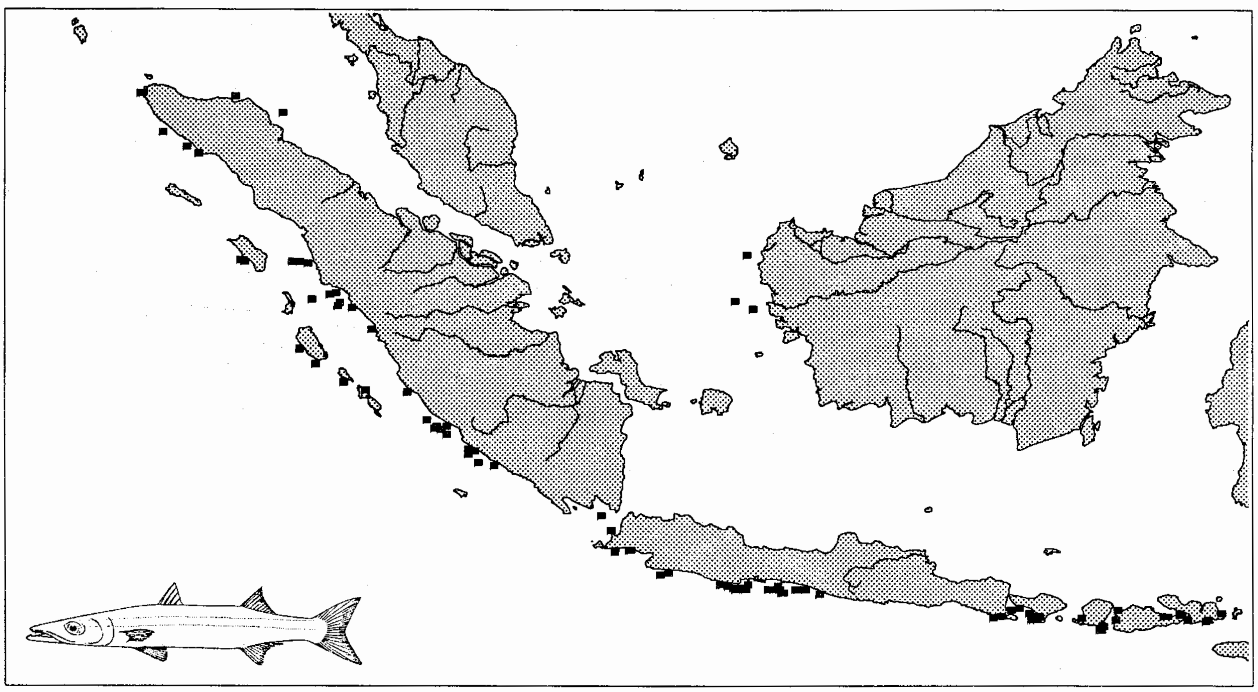

Fig. 106. Distribution of obtuse barracuda, *Sphyraena obtusata* based on records of the surveys of *R/Vs Mutiara 4, Bawal Putih 2, Jurong* and *Dr. Fridtjof Nansen.* *[Gambar 106. Penyebaran ikan alu-alu,* Sphyraena obtusata, *berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong *dan* Dr. Fridtjof Nansen.*]*

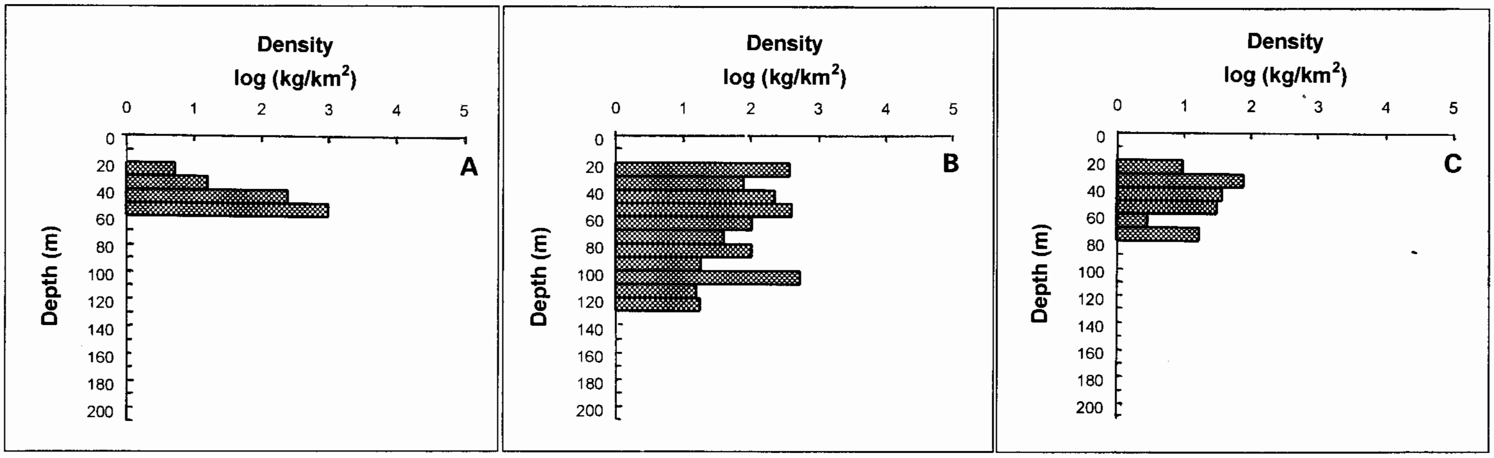

Fig. 107. Depth distribution of obtuse barracuda, *Sphyraena obtusata* based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen,* (B) *Jurong* and (C) *Bawal Putih 2.* *[Gambar 107. Penyebaran kedalaman ikan alu-alu,* Sphyraena obtusata*, berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen, *(B)* Jurong *dan (C)* Bawal Putih 2.*]*

Pampus argenteus (Euphrasen, 1788)

Silver pomfret (English); Bawal putih (Indonesian); Dawah, Dawahan, Lawang, Lowang (Java); Bawal, Bawal putih (West Java, Jakarta); Njiuran, Njor njoran, Potean, Potian, Tangkolok, Tjeplak (Madura); Manriwasakebo (South Sulawesi, Makassar); Peda-peda puti (South Sulawesi, Bugis).

Body very deep, and compressed. Operculum absent; gill opening reduced to a vertical slit on the side of the body; gill membrane broadly united to isthmus. Dorsal and anal fins preceded by a series of 5 to 10 blade-like spines with anterior and posterior points. Pelvic fins absent. Caudal fin deeply forked, the lower lobe longer than the upper. Color is gray above grading to silvery white towards the belly, with small black dots all over the body. Fins are faintly yellow; vertical fins with dark edges. L_{max1} = 60 cm; L_{max2} = n.a.; L_{max3} = 30.7 cm FL (Fig. 108A). See Fig. 108B and Table 58 for length-weight relationship.

Indo-West Pacific: from the Persian Gulf east to Southeast Asia, Indonesia (Fig. 109) and north to southern Japan.

Found in coastal waters over muddy bottoms, associated with prawns and *Nemipterus* and *Leiognathus* species. Forms schools which can be large and abundant. Depth range: 10-110 m (Fig. 110). Feeds on ctenophores, salps, medusae and other zooplankton groups. Table 59 presents a set of growth parameters from Indonesia.

References: 559, 1314, 2047, 3517, 4606, 4789, 5204, 5736, 5756, 6365

Table 58. Length-weight (g/[FL;cm]) relationship of silver pomfret, *Pampus argenteus*, in Indonesia.
[Tabel 58. Hubungan panjang-berat (g/[FL; cm]) ikan bawal putih, Pampus argenteus, *di Indonesia.]*

Parameter	Estimate
a	0.1660
s.e.(a)	0.0496
b	2.5033
s.e.(b)	0.1043
r^2	0.9715

Table 59. Growth parameters of silver pomfret, *Pampus argenteus.*
[Tabel 59. Parameter pertumbuhan ikan bawal putih, Pampus argenteus.*]*

Parameter	A
L_∞ (TL, cm)	31.5
K (year^{-1})	0.95

A. Java Sea (Central Java) (Ref. 1314)

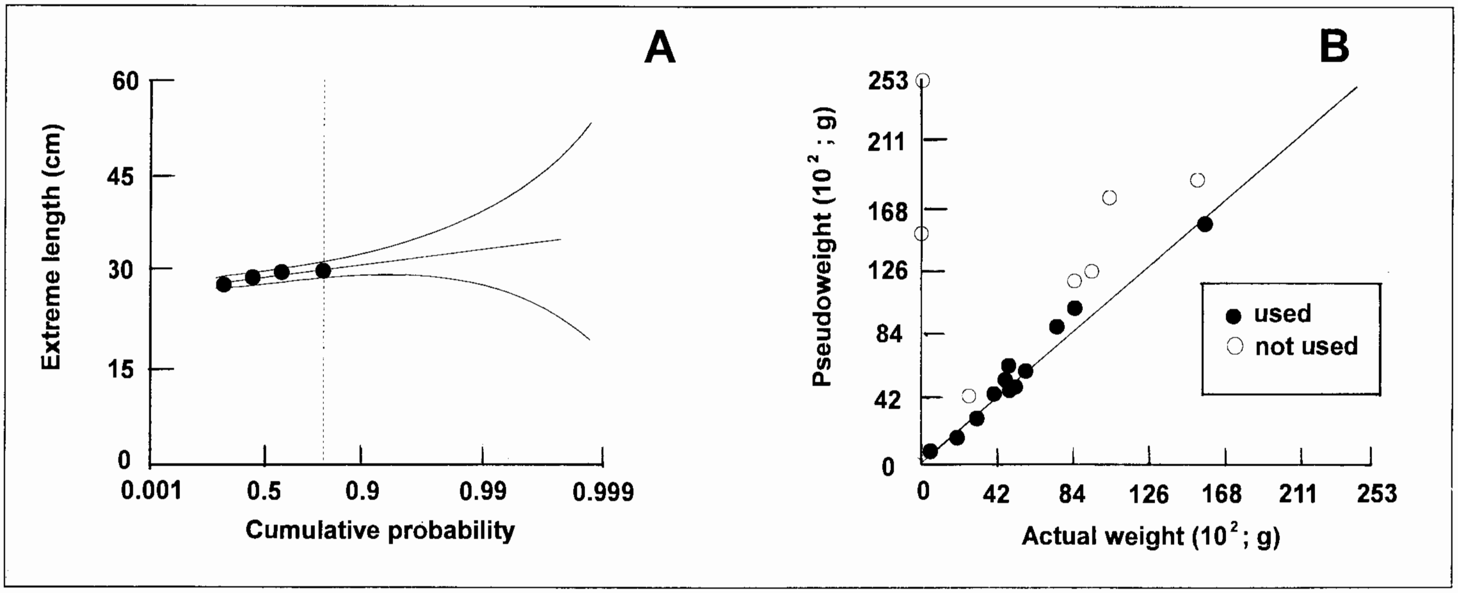

Fig. 108. (A) Extreme value plot for silver pomfret, *Pampus argenteus*, in Indonesia based on data from *R/Vs Mutiara 4* and *Jurong* showing maxima of 4 length-frequency samples, and estimate of L_{max3} = 30.7 ± 1.15 cm FL. (B) Predicted *vs.* observed weights (in g wet weight) of 13 length-frequency samples of silver pomfret, *Pampus argenteus*, from Western Indonesia based on data from *R/Vs Mutiara 4* and *Jurong* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 58). Open dots represent outliers, not used for analysis.

[Gambar 108. (A) Gambaran nilai ekstrim ikan bawal putih, Pampus argenteus, *di Indonesia berdasarkan data dari kapal-kapal penelitian* Mutiara 4 *dan* Jurong *menunjukkan nilai maksimum 4 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 30.7 ± 1.15 cm FL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 13 contoh frekuensi-panjang ikan bawal putih,* Pampus argenteus*, dari Indonesia bagian barat berdasarkan data kapal-kapal penelitian* Mutiara 4 *dan* Jurong *sebagai luaran perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 58). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

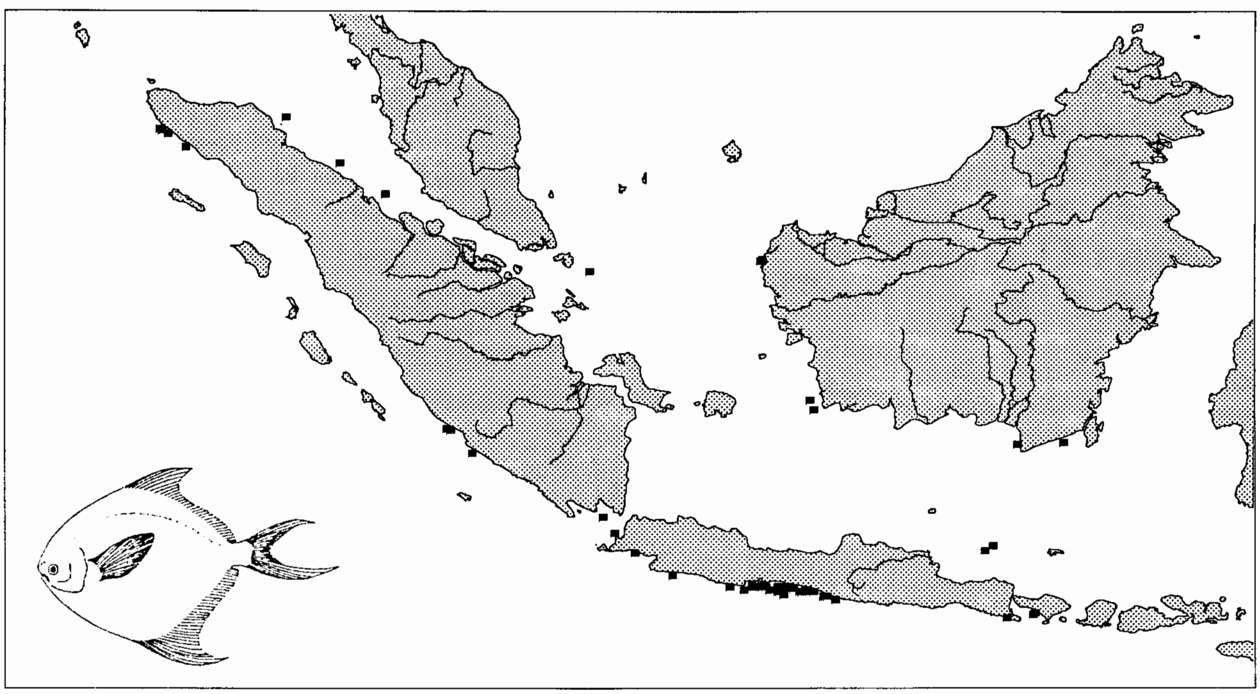

Fig. 109. Distribution of silver pomfret, *Pampus argenteus* based on records of the surveys of *R/Vs Mutiara 4, Bawal Putih 2, Jurong, Lemuru* and *Dr. Fridtjof Nansen.*

[Gambar 109. Penyebaran ikan bawal putih, Pampus argenteus*, berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong, Lemuru *dan* Dr. Fridtjof Nansen.*]*

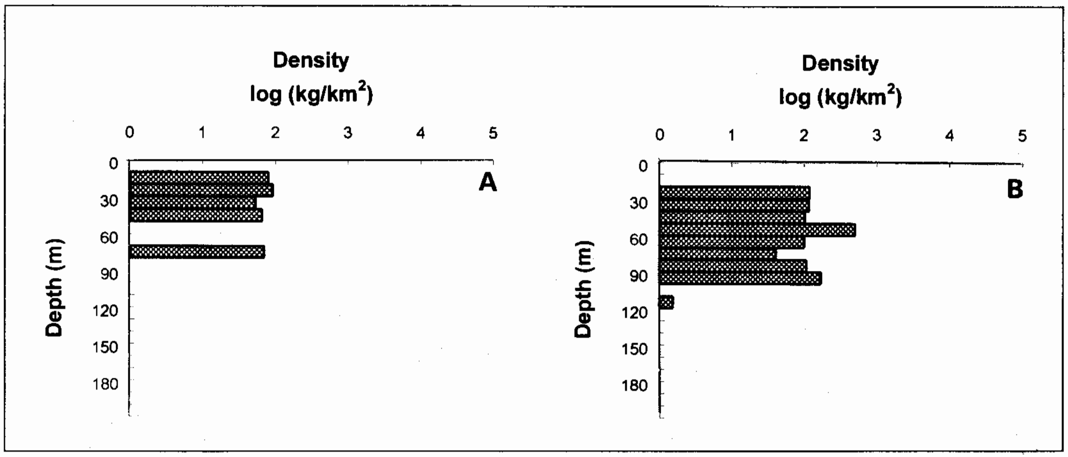

Fig. 110. Depth distribution of silver pomfret, *Pampus argenteus*, based on surveys of *R/Vs* (A) *Mutiara 4* and (B) *Jurong*.
[Gambar 110. Penyebaran kedalaman ikan bawal putih, Pampus argenteus, *berdasarkan survei kapal-kapal penelitian (A)* Mutiara 4 *dan (B)* Jurong.*]*

Terapon jarbua (Forsskål, 1775)

Jarbua terapon (English); Kerong-kerong tambi (Indonesian); Djambrung, Djandjan, Djangdjan, Kerong-kerong (Java); Djambron, Erong-erong, Kerong-kerong tambi (West Java, Jakarta); Kerongan (Central Java); Djambon, Longkerong (Madura); Keretang (East Sumatra); Kerung-kerung, Mangahua (South Sulawesi, Makassar); Karong-karong (South Sulawesi, Bugis).

Lower opercular spine extending well beyond the opercular flap. Post temporal bone exposed posteriorly and serrate. Body color is fawn above, cream below, nape dark; head, body and fins with an iridescent sheen. Three or four curved dark brown bands run from the nape to the hind part of the body, the lowermost continuing across the middle of the caudal fin. Dorsal spines: 12-12; soft rays: 10-10; anal spines: 3-3; soft rays: 8-8. L_{max1} = 33 cm TL; L_{max2} = n.a.; L_{max3} = 19.7 cm FL (Fig. 111A). See Fig. 111B and Table 60 for length-weight relationship.

From the Red Sea in the Indian Ocean to Southeast Asia, Indonesia (Fig. 112): north to southern Japan, south to Samoa, Belau in Micronesia and Lord Howe Islands.

Occurs over shallow sandy bottoms, in the vicinity of river mouths. Depth range: 20-290 m (Fig. 113). Feeds on sand-dwelling invertebrates.

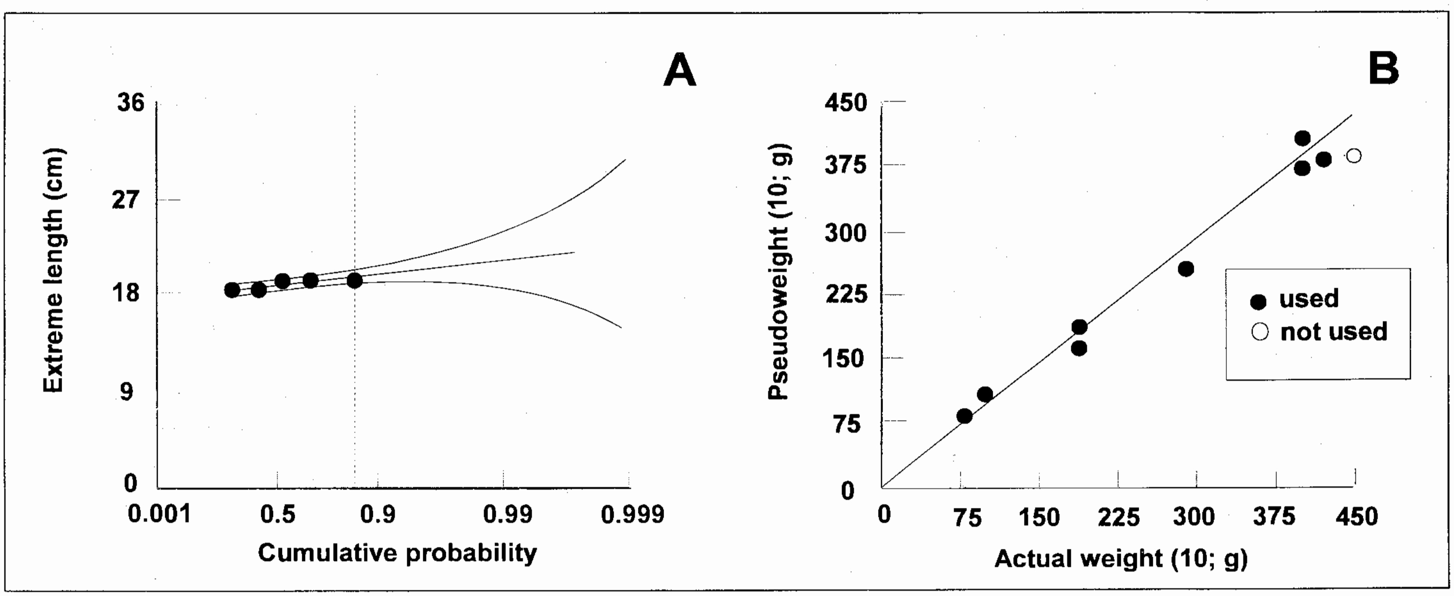

Fig. 111. (A) Extreme value plot for Jarbua terapon, *Terapon jarbua*, in Indonesia based on data from *R/V Jurong* showing maxima of 5 length-frequency samples, and estimate of L_{max3} = 19.7 ± 0.65 cm FL. (B) Predicted *vs.* observed weights (in g wet weight) of 8 length-frequency samples of Jarbua terapon, *Terapon jarbua*, from Western Indonesia based on data from *R/V Jurong* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 60). Open dot represents outlier, not used for analysis.
[Gambar 111. (A) Gambaran nilai ekstrim ikan kerong-kerong tambi, Terapon jarbua, *di Indonesia berdasarkan data dari kapal penelitian* Jurong *menunjukkan nilai maksimum 5 contoh frekuensi-panjang, dan angka perkiraan* L_{max3} *= 19.7 ± 0.65 cm FL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 8 contoh ikan kerong-kerong tambi,* Terapon jarbua, *dari Indonesia bagian barat berdasarkan data dari kapal penelitian* Jurong *sebagai output perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 60). Bulatan kosong mewakili suatu pengamatan yang tidak dipakai dalam analisis.]*

References: 1602, 2857, 3539, 4327, 4515, 4959, 4967, 5213, 5255, 5450, 5525, 5736, 5756, 5970, 6026, 6365

Table 60. Length-weight (g/[FL;cm]) relationship of Jarbua terapon, *Terapon jarbua*, in Indonesia.
[Tabel 60. Hubungan panjang-berat (g/[FL; cm]) ikan kerong-kerong tambi, Terapon jarbua, *di Indonesia.]*

Parameter	Estimate
a	0.0748
s.e. (a)	0.0896
b	2.5241
s.e. (b)	0.4443
r^2	0.9824

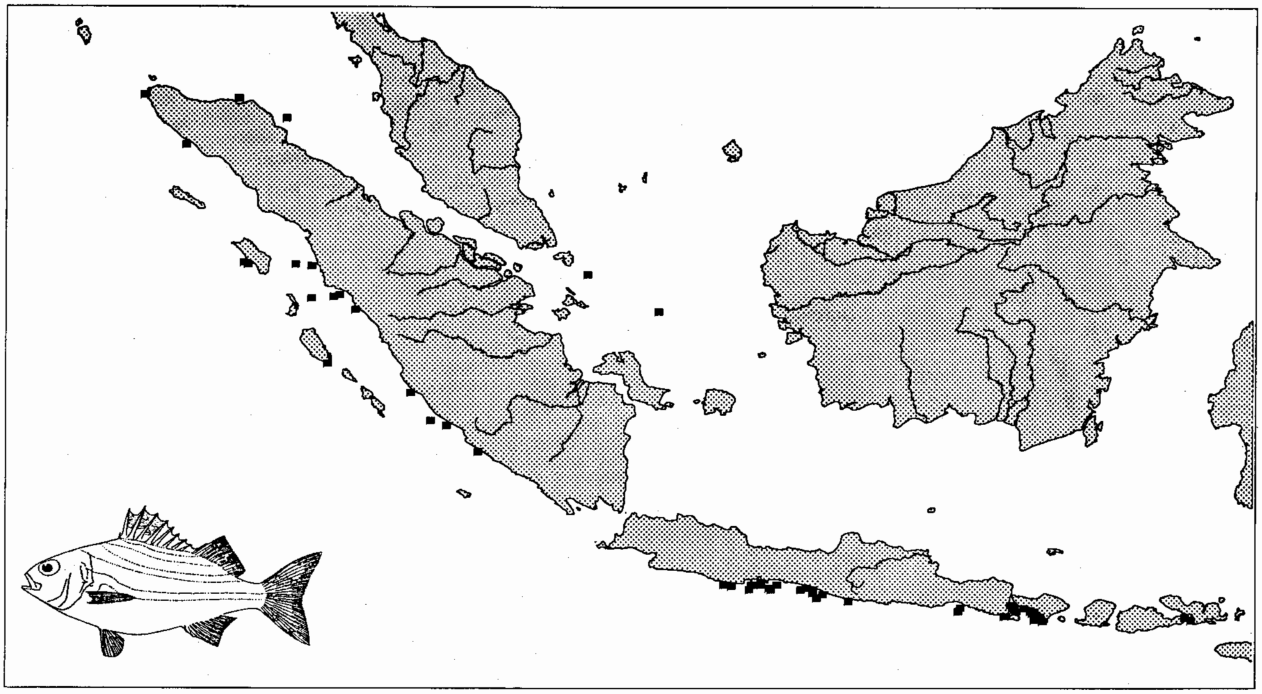

Fig. 112. Distribution of Jarbua terapon, *Terapon jarbua,* based on records of the surveys of *R/Vs Mutiara 4, Bawal Putih 2, Jurong* and *Dr. Fridtjof Nansen.*
[Gambar 112. Penyebaran ikan kerong-kerong tambi, Terapon jarbua, *berdasarkan laporan survei dari kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong *dan* Dr. Fridtjof Nansen.*]*

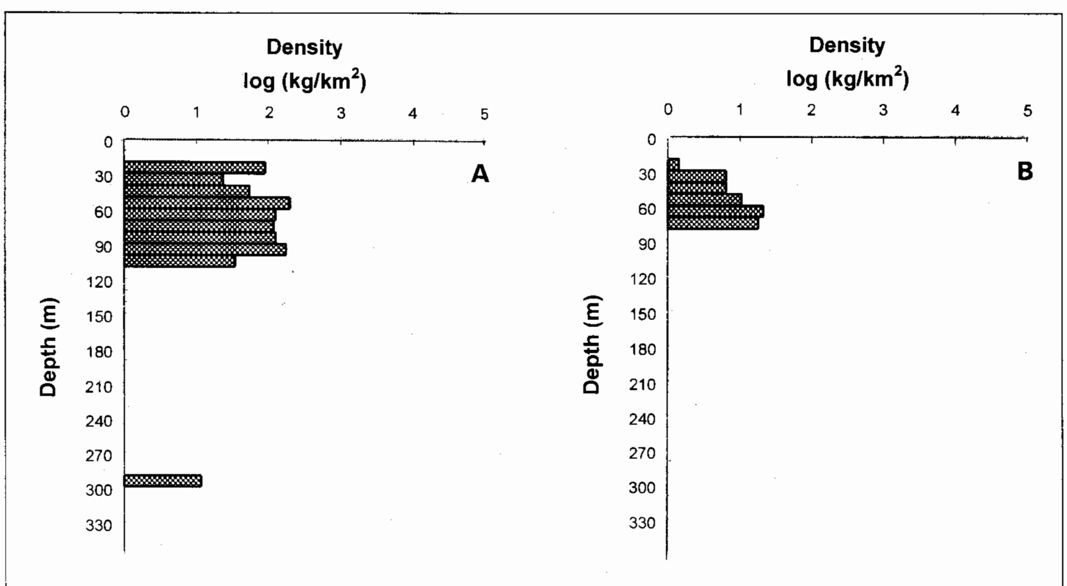

Fig. 113. Depth distribution of Jarbua terapon, *Terapon jarbua*, based on surveys of *R/Vs* (A) *Jurong* and (B) *Bawal Putih 2.*
[Gambar 113. Penyebaran kedalaman ikan kerong-kerong tambi, Terapon jarbua, *berdasarkan survei kapal-kapal penelitian (A)* Jurong *dan (B)* Bawal Putih 2.*]*

Trichiurus lepturus (Linnaeus, 1758)

Largehead hairtail (English); Lajur (Indonesian); Djogor (Java); Lajur (West Java, Jakarta); Ladjur (Madura); Ladjuru (South Sulawesi, Makassar).

Body extremely elongate, compressed and tapering to a point. Mouth large with a dermal process at the tip of each jaw. Dorsal fin relatively high; anal fin reduced to minute spinules usually embedded in the skin or slightly breaking through; anterior margin of pectoral fin spine not serrated. Pelvic and caudal fins absent. Lateral line beginning at the upper margin of the gill cover, running oblique to behind the tip of the pectoral fins, then straight close to the ventral contour. Fresh specimens steely blue with silvery reflections, becoming uniformly silvery gray sometime after death. Dorsal spines: 3-3; soft rays: 130-135; anal spines: -; soft rays: 100-105. L_{max1} = 213 cm TL; L_{max2} = n.a.; L_{max3} = 125.8 cm TL (Fig. 114A). See Fig. 114B and Table 61 for length-weight relationship.

Throughout tropical waters such as Indonesia (Fig. 115) and temperate waters of the world.

Occurs on continental shelf, occasionally in shallow waters and at surface at night. Depth range: 55-385 m (Fig. 116). Immature fish feed mostly on euphausiids, small pelagic planktonic crustaceans and small fishes while adults feed on anchovies, sardines, myctophiids etc. and occasionally on squid and crustaceans. Adults and juveniles have opposing complementary vertical diurnal feeding migrations.

References: 171, 181, 245, 276, 312, 559, 591, 637, 1263, 1348, 1349, 1350, 1351, 1652, 1751, 1809, 2221, 2302, 2308, 2311, 2682, 2857, 3136, 3383, 3397, 3669, 3670, 3678, 4604, 4733, 4743, 4789, 4830, 4868, 4883, 4931, 5204, 5213, 5217, 5219, 5252, 5287, 5516, 5525, 5541, 5756, 6181, 6365, 6490

Table 61. Length-weight (g/[TL;cm]) relationship of largehead hairtail, *Trichiurus lepturus*, in Indonesia. *[Tabel 61. Hubungan panjang-berat (g/[TL;cm]) ikan layur,* Trichiurus lepturus, *di Indonesia.]*

Parameter	Estimate
a	0.0009
s.e. (a)	0.0014
b	2.9686
s.e. (b)	0.2967
r^2	0.9019

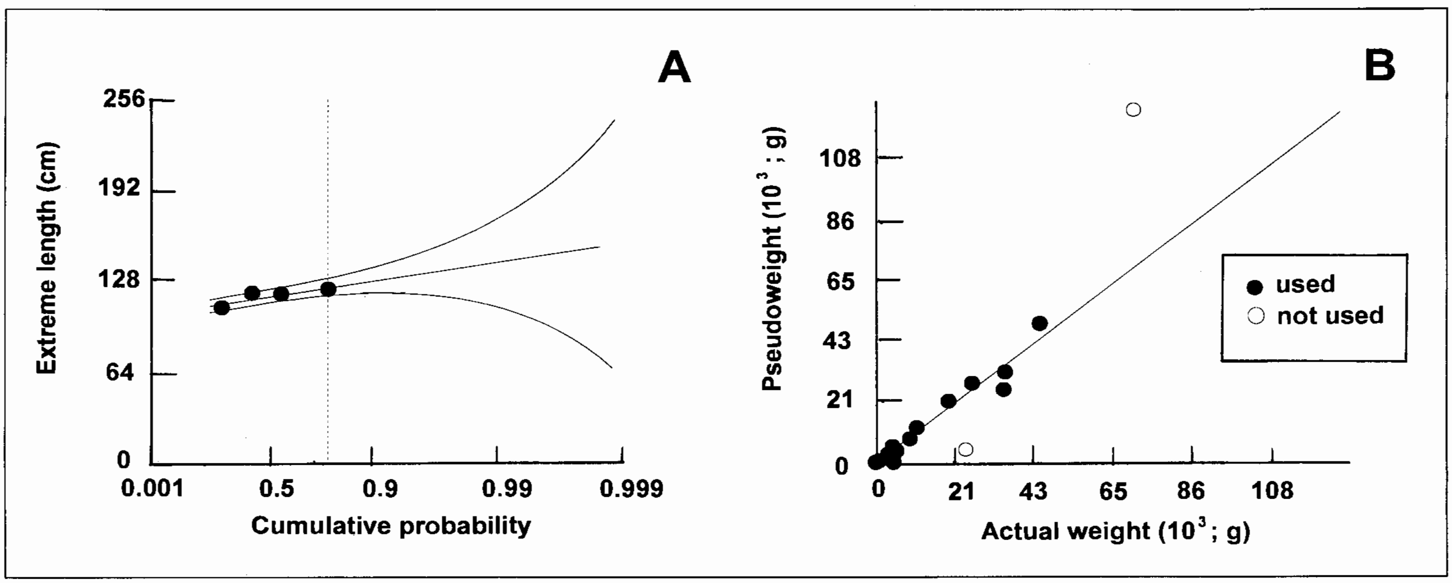

Fig. 114. (A) Extreme value plot for largehead hairtail, *Trichiurus lepturus*, in Indonesia based on data from *R/Vs Mutiara 4* and *Jurong* showing maxima of 4 length-frequency samples, and estimate of L_{max3} = 125.8 $\pm$ 6.0 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 17 length-frequency samples of largehead hairtail, *Trichiurus lepturus*, from Western Indonesia based on data from *R/Vs Mutiara 4* and *Jurong* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 61). Open dots represent outliers, not used for analysis.
[Gambar 114. (A) Gambaran nilai ekstrim ikan layur, Trichiurus lepturus, *di Indonesia berdasarkan data dari kapal-kapal penelitian* Mutiara 4 *dan* Jurong *menunjukkan nilai maksimum 4 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 125.8 $\pm$ 6.0 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) 17 contoh frekuensi-panjang ikan layur,* Trichiurus lepturus, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4 *dan* Jurong *sebagai luaran perangkat lunak ABee (lihat Boks 1), dan yang memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 61). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

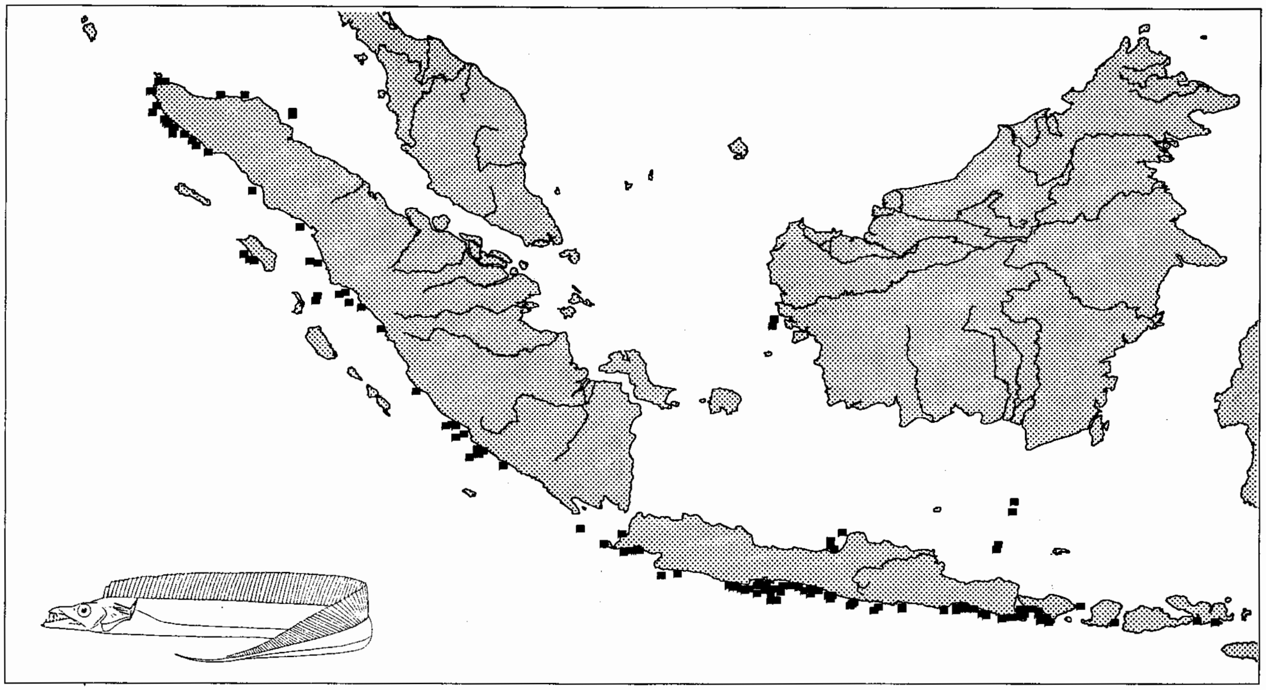

Fig. 115. Distribution of largehead hairtail, *Trichiurus lepturus*, based on records of the surveys of *R/V*s *Mutiara 4, Bawal Putih 2, Jurong* and *Dr. Fridtjof Nansen.*
[Gambar 115. Penyebaran ikan layur, Trichiurus lepturus*, berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong *dan* Dr. Fridtjof Nansen.*]*

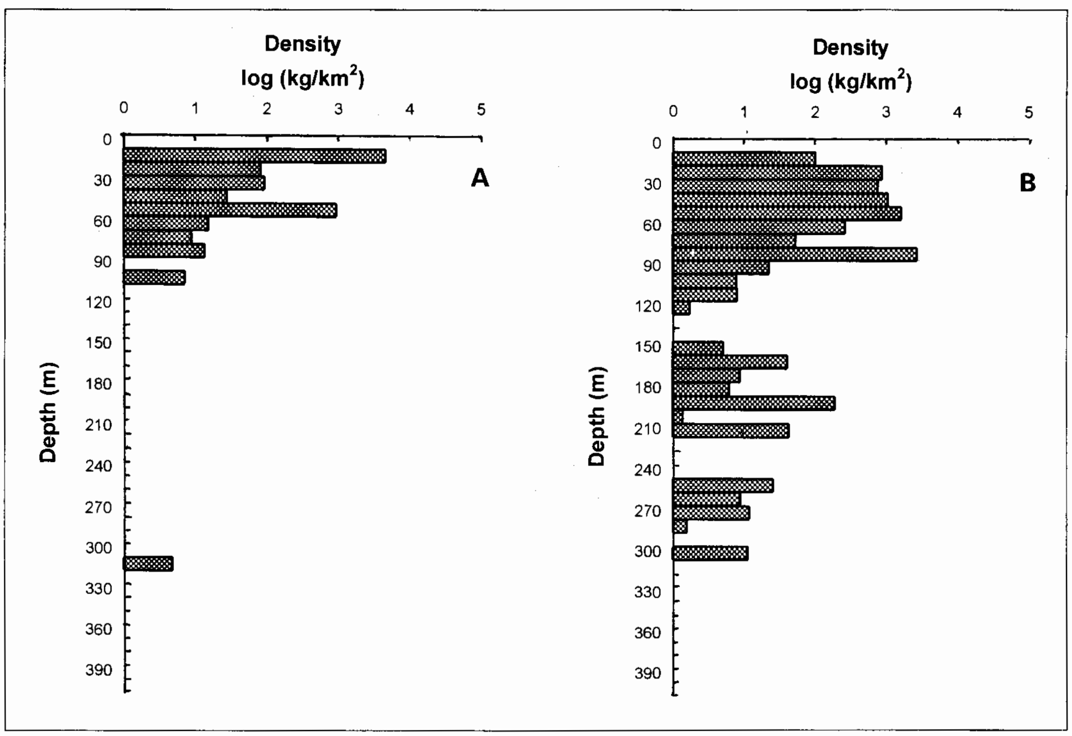

Fig. 116. Depth distribution of largehead hairtail, *Trichiurus lepturus*, based on surveys of *R/V*s (A) *Dr. Fridtjof Nansen* and (B) *Jurong*.
[Gambar 116. Penyebaran kedalaman ikan layur, Trichiurus lepturus*, berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen *dan (B)* Jurong.*]*

Abalistes stellatus (Lacepède, 1798)

Starry triggerfish (English); Kambing-kambing (Indonesian).

Scales enlarged above the pectoral fin base and just behind the gill slit to form a flexible tympanum; scales of posterior body with prominent keels, forming longitudinal ridges. A prominent groove in the skin extending anteriorly from front of eye for a distance of about 1 eye diameter. Caudal peduncle depressed. Caudal fin rays of adults prolonged above and below. Dorsal spines: 3-3; soft rays: 25-27; anal spines: 0-0; soft rays: 24-26. L_{max1} = 60 cm; L_{max2} = n.a.; L_{max3} = 51.5 cm TL (Fig. 117A). See Fig. 117B and Table 62 for length-weight relationship.

Indo-West Pacific, from East Africa and the Red Sea, Southeast Asia, Indonesia (Fig.118) and thence to Northern Australia and Japan; also reported from the eastern tropical Atlantic.

Inhabits coastal areas, usually found over muddy and sandy bottoms, also around reefs, together with the sponges and algae. Depth range: 20-170 m (Fig. 119). Feeds on benthic animals.

References: 28, 182, 2683, 2857, 3109, 3128, 3804, 3807, 4789, 5193, 5213, 5255, 5450, 5736, 5756, 6026, 6365, 6567

Table 62. Length-weight (g/[TL;cm]) relationship of starry triggerfish, *Abalistes stellatus*, in Indonesia.
Tabel 62. Hubungan panjang-berat (g/[TL;cm]) ikan kambing-kambing, Abalistes stellatus, *di Indonesia.*

Parameter	Estimate
a	0.0281
s.e. (a)	0.0085
b	2.8746
s.e. (b)	0.0845
r^2	0.9877

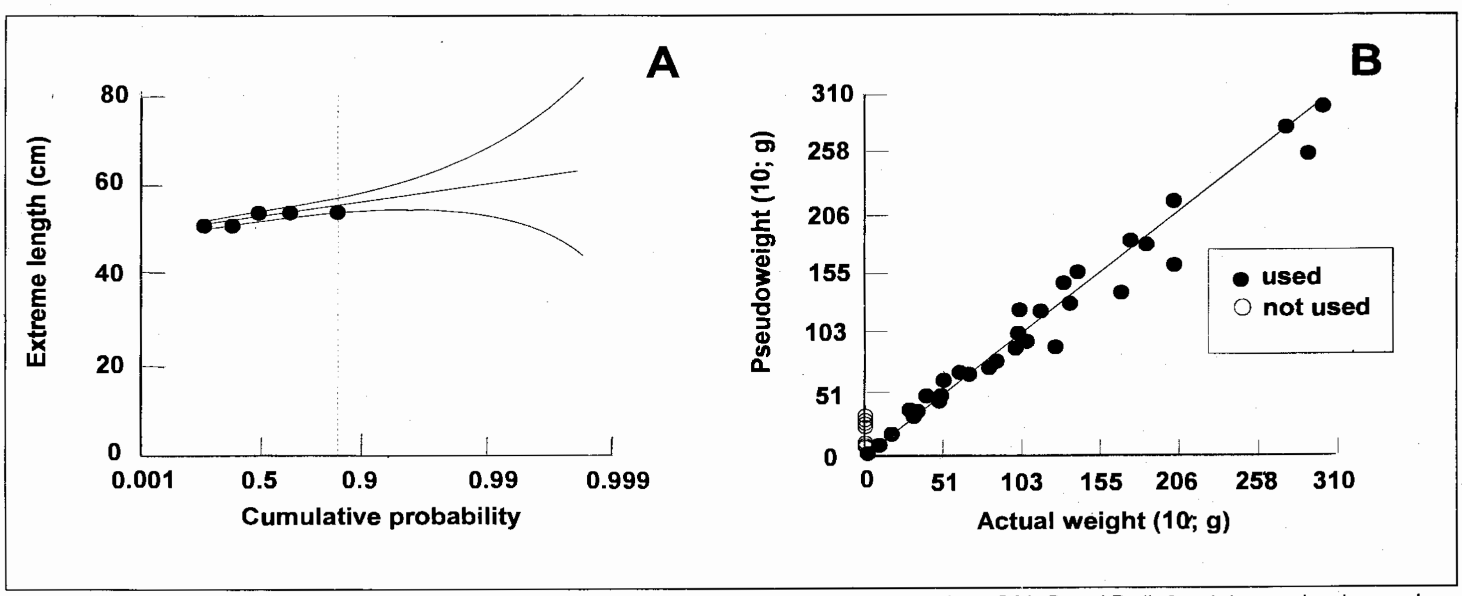

Fig. 117. (A) Extreme value plot for starry triggerfish, *Abalistes stellatus*, in Indonesia based on data from *R/Vs Bawal Putih 2* and *Jurong* showing maxima of 5 length-frequency samples, and estimate of L_{max3} = 51.5 ± 1.25 cm TL. (B) Predicted *vs.* observed weights (in g wet weight) of 31 length-frequency samples of starry triggerfish, *Abalistes stellatus*, from Western Indonesia based on data from *R/Vs Mutiara 4, Jurong* and *Bawal Putih 2* as output by the ABee software (see Box 1), and allowing estimation of a length-weight relationship (see Table 62). Open dot(s) represent outliers, not used for analysis. *[Gambar 117. (A) Gambaran nilai ekstrim ikan kambing-kambing,* Abalistes stellatus, *di Indonesia berdasarkan data dari kapal-kapal penelitian* Bawal Putih 2 *dan* Jurong *menunjukkan nilai maksimum 5 contoh frekuensi-panjang, dan angka perkiraan L_{max3} = 51.5 ± 1.25 cm TL. (B) Berat prediksi terhadap berat observasi (dalam g berat basah) dari 31 contoh frekuensi-panjang ikan kambing-kambing,* Abalistes stellatus, *dari Indonesia bagian barat berdasarkan data dari kapal-kapal penelitian* Mutiara 4, Jurong *dan* Bawal Putih 2 *sebagai luaran perangkat lunak ABee (lihat Box 1)), dan memungkinkan estimasi suatu hubungan panjang-berat (lihat Tabel 62). Bulatan-bulatan kosong mewakili pengamatan-pengamatan yang tidak dipakai dalam analisis.]*

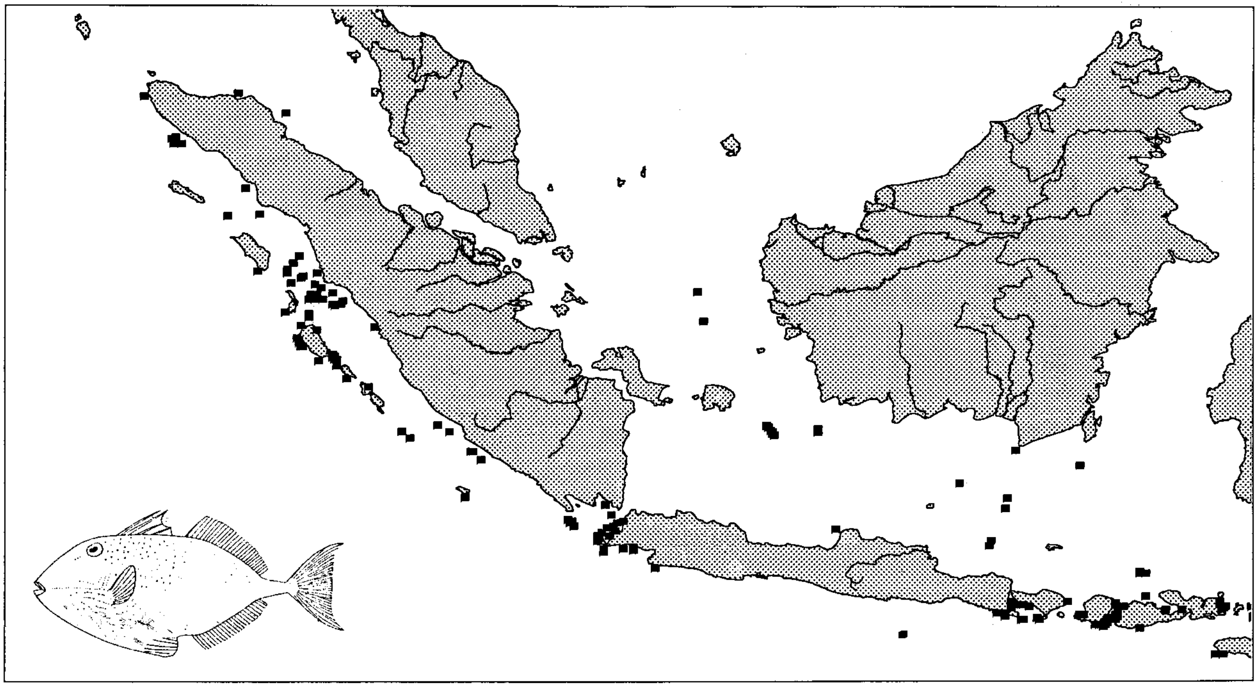

Fig. 118. Distribution of starry triggerfish, *Abalistes stellatus*, based on records of the surveys of *R/Vs Mutiara 4, Bawal Putih 2, Jurong* and *Dr. Fridtjof Nansen.*
[Gambar 118. Penyebaran ikan kambing-kambing, Abalistes stellatus, *berdasarkan laporan survei kapal-kapal penelitian* Mutiara 4, Bawal Putih 2, Jurong *dan* Dr. Fridtjof Nansen.*]*

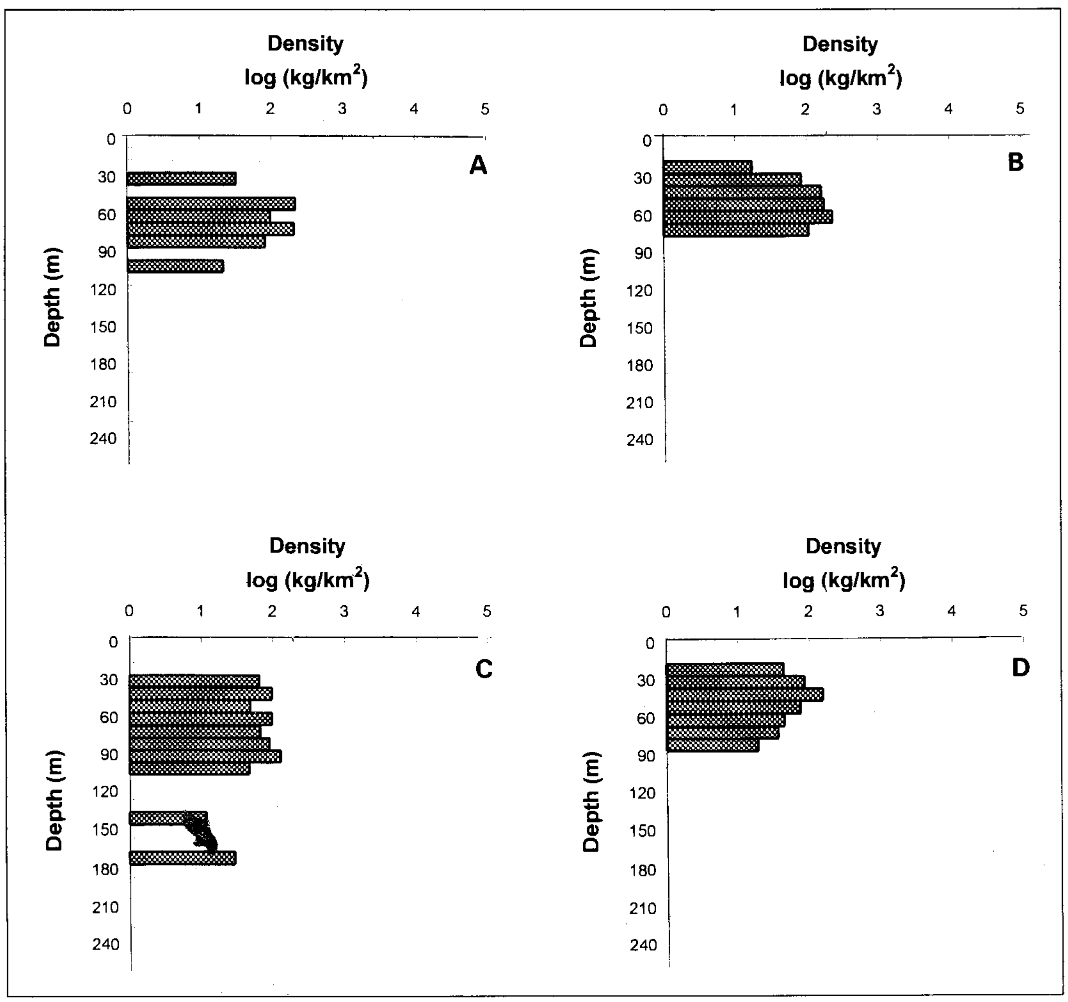

Fig. 119. Depth distribution of starry triggerfish, *Abalistes stellatus*, based on surveys of *R/Vs* (A) *Dr. Fridtjof Nansen,* (B) *Mutiara 4,* (C) *Jurong* and (D) *Bawal Putih 2.*
[Gambar 119. Penyebaran kedalaman ikan kambing-kambing, Abalistes stellatus, *berdasarkan survei kapal-kapal penelitian (A)* Dr. Fridtjof Nansen, *(B)* Mutiara 4, *(C)* Jurong *dan (D)* Bawal Putih 2.*]*

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Elasmobranchii (sharks and rays)	
Heterodontiformes (bullhead and horn sharks)	
Heterodontidae	**Bullhead, horn, or Port Jackson sharks**
Heterodontus zebra (Gray 1831)	Zebra bullhead shark, (M, Dan), Ref. 247. Max. 125 cm TL. From Sulawesi and Ambon. Also Ref.: 559, 5978.
Orectolobiformes (carpet sharks)	
Ginglymostomatidae	**Nurse sharks**
Nebrius ferrugineus (Lesson 1830)	Tawny nurse shark, (M, Fi, Sport, Dan), Ref. 247. Max. 320 cm TL. Also Ref.: 5978.
Hemiscylliidae	**Bamboo sharks**
Chiloscyllium griseum Müller & Henle 1838	Grey bambooshark, (M, Br, Fi), Ref. 247. Max. 74 cm TL. Also Ref.: 5978.
Chiloscyllium indicum (Gmelin 1789)	Slender bambooshark, (M, Fi), Ref. 247. Max. 65 cm TL. Also Ref.: 5978.
Chiloscyllium plagiosum (Bennett 1830)	Whitespotted bambooshark, (M, Fi), Ref. 247. Max. 69 cm TL. Also Ref.: 5978.
Chiloscyllium punctatum Müller & Henle 1838	Brownbanded bambooshark, (M, Fi), Ref. 247. Max. Max. 104 cm TL. Also Ref.: 5978.
Hemiscyllium freycineti (Quoy & Gaimard 1824)	Indonesia speckled carpetshark, (M), Ref. 247. Max. 46 cm TL. Museum. MNHN A.7792 (Syntypes, Waigiu (Waigeo), Indonesia). Also Ref.: 5978.
Hemiscyllium hallstromi Whitley 1967	Papuan epaulette shark, (M), Ref. 247. Max. 75 cm TL. Also Ref.: 5978.
Hemiscyllium ocellatum (Bonnaterre 1788)	Epaulette shark, (M), Ref. 247. Max. 107 cm TL. Also Ref.: 6445.
Hemiscyllium strahani 1967	Hooded carpetshark, (M), Ref. 247. Max. 75 cm TL. Also Ref.: 5978.
Hemiscyllium trispeculare Richardson 1843	Speckled carpetshark, (M), Ref. 5978. Max. 64 cm TL.
Orectolobidae	**Carpet or nurse sharks**
Eucrossorhinus dasypogon (Bleeker 1867)	Tasselled wobbegong, (M, Fi, Dan), Ref. 247. Max. 366 cm TL. Museum. BMNH 1867.11.28.209 (Syntypes, Waigiu and Aru, Indonesia).
Orectolobus ornatus (De Vis 1883)	Ornate wobbegong, (M, Fi, Dan), Ref. 247. Max. 288 cm TL.
Rhincodontidae	**Whale shark**
Rhincodon typus Smith 1828	Whale shark, (M, Fi, Thr), Ref. 247. Max. 1370 cm TL. Also Ref.: 5978.
Stegostomatidae	**Zebra sharks**
Stegostoma fasciatum (Hermann 1783)	Zebra shark, (M, Fi), Ref. 247. Max. 354 cm TL.
Carchariniformes (ground sharks)	
Carcharhinidae	**Requiem sharks**
Carcharhinus albimarginatus (Rüppell 1837)	Silvertip shark, (M, Fi, Sport, Dan), Ref. 244. Max. 300 cm TL.
Carcharhinus amblyrhynchoides (Whitley 1934)	Graceful shark, (M, Fi, Dan), Ref. 244. Max. 140 cm TL. Also Ref.: 5978.
Carcharhinus amblyrhynchos (Bleeker 1856)	Grey reef shark, (M, Fi, Dan), Ref. 244. Max. 255 cm TL. Also Ref.: 5978.
Carcharhinus amboinensis (Müller & Henle 1839)	Pigeye shark, (M, Fi, Dan), Ref. 244. Max. 280 cm TL Also Ref.: 5978.
Carcharhinus brevipinna (Müller & Henle 1839)	Spinner shark, (M, Fi, Sport), Ref. 244. Also Ref.: 5978.
Carcharhinus dussumieri (Valenciennes 1839)	W
Carcharhinus falciformis (Bibron 1839)	S
Carcharhinus hemiodon (Valenciennes 1839)	P
Carcharhinus leucas (Valenciennes 1839)	B
Carcharhinus limbatus (Valenciennes 1839)	B
Carcharhinus longimanus (Poey 1861)	O
Carcharhinus macloti (Müller & Henle 1839)	H
Carcharhinus melanopterus (Quoy & Gaimard 1824)	B
Carcharhinus plumbeus (Nardo 1827)	S
Carcharhinus sealei (Pietschmann 1913)	B
Carcharhinus sorrah (Valenciennes 1839)	
Galeocerdo cuvier (Péron & Lesueur 1822)	Ti
Glyphis glyphis (Müller & Henle 1839)	S
Lamiopsis temmincki (Müller & Henle 1839)	B
Loxodon macrorhinus Müller & Henle 1839	Sli
Negaprion acutidens (Rüppell 1837)	Sic
Prionace glauca (Linnaeus 1758)	B
Rhizoprionodon acutus (Rüppell 1837)	M
Rhizoprionodon oligolinx Springer 1964	G
Scoliodon laticaudus Müller & Henle 1838	S
Triaenodon obesus (Rüppell 1837)	V
Hemigaleidae	**V**
Chaenogaleus macrostoma (Bleeker 1852)	H
Hemigaleus microstoma Bleeker 1852	S
Proscylliidae	**F**
Proscyllium habereri Hilgendorf 1904	G
Scyliorhinidae	**C**
Apristurus sibogae (Weber 1913)	F

Table 2. Continuation.
[Tabel 2. Sambungan.]

Apristurus spongiceps (Gilbert 1895)	Spongehead catshark, (M), Ref. 244. Max. 50 cm TL.
Apristurus verweyi (Fowler 1934)	Borneo catshark, (M, En), Ref. 244. Max. 30 cm TL.
Atelomycterus marmoratus (Bennett 1830)	Coral catshark, (M, Fi), Ref. 244. Max. 70 cm TL. Also Ref.: 5978.
Halaelurus boesemani Springer & D'Aubrey 1972	Speckled catshark, (M), Ref. 244. Max. 48 cm TL. Ambon Island.
Scyliorhinus garmani (Fowler 1934)	Brownspotted catshark, (M), Ref. 244. Max. 36 cm TL.
Sphyrnidae	**Hammerhead, bonnethead, scoophead shark**
Eusphyra blochii (Cuvier 1816)	Winghead shark, (M, Fi), Ref. 244 Max. 152 cm TL.From southwest Sumatra to Timor Sea (Ref. 5978).
Sphyrna lewini (Griffith & Smith 1834)	Scalloped hammerhead, (M, Br, Fi, Sport, Dan), Ref. 244. Max. 420 cm TL. From southwest Sumatra to Timor Sea (Ref. 5978).
Sphyrna mokarran (Rüppell 1837)	Great hammerhead, (M, Dan), Ref. 5978. Max. 610 cm TL.
Lamniformes (mackerel sharks)	
Alopiidae	**Thresher sharks**
Alopias vulpinus (Bonnaterre 1788)	Thresher shark, (M, Fi, Dan), Ref. 247. Max. 609 cm TL. Also Ref.: 5978.
Lamnidae	**Mackerel sharks, white sharks**
Isurus oxyrinchus Rafinesque 1810	Shortfin mako, (M, Fi, Sport, Dan), Ref. 247. Max. 400 cm TL. Also Ref.: 5978.
Odontaspididae	**Sand tigers**
Carcharias taurus Rafinesque 1810	Sandtiger shark, (M, Dan), Ref. 5978. Max. 320 cm.
Pseudocarcharias kamoharai (Matsubara 1936)	Crocodile shark, (M), Ref. 5978. Max. 110 cm TL.
Hexanchiformes (frill and cow sharks)	
Hexanchidae	**Cow sharks**
Heptranchias perlo (Bonnaterre 1788)	Sharpnose sevengill shark, (M, Fi, Dan), Ref. 247. Max. 137 cm TL. Also Ref.: 5978.
Hexanchus griseus (Bonnaterre 1788)	Bluntnose sixgill shark, (M, Fi, Sport, Dan), Ref. 247. Max. 500 cm. Also Ref.: 5978.
Squaliformes (bramble, sleeper and dogfish sharks)	
Squalidae	**Dogfish sharks**
Centrophorus moluccensis Bleeker 1860	Smallfin gulper shark, (M, Fi), Ref. 247. Max. 100 cm. Museum. Rijksmuseum van Natuurlijke Histoire RMNH 7415 (Holotype, Ambon).
Etmopterus lucifer Jordan & Snyder 1902	Blackbelly lanternshark, (M), Ref. 247. Max. 42 cm TL. Also Ref.: 5978.
Pristiformes (sawfishes)	
Pristidae	**Sawfishes**
Anoxypristis cuspidata (Latham 1794)	Pointed sawfish, (M, Br, Fi, Sport, Dan), Ref. 8630. Max. 470 cm TL. Also Ref.: 5978.
Pristis microdon Latham 1794	Largetooth sawfish, (M, Br, Fr, Fi, Dan), Ref. 7050. Max. 600 cm TL. Confirmed records from several major river basins (Ref. 6871). Known from Java, Borneo, and Sumatra (Ref. 9859). In range Ref.: 4429.

Pristis pectinata Latham 1794	Sma
Pristis zijsron Bleeker 1851	Long M fre Al
Torpediniformes (electric rays)	
Narkidae	
Narcine indica Henle 1834	(M, D Re
Narcine timlei (Bloch & Schneider 1801)	Spot Kr
Narke dipterygia (Bloch & Schneider 1801)	Num Kr
Rajiformes (skates and rays)	
Anacanthobatidae	**Smo**
Anacanthobatis borneensis Chan 1965	(M),
Rajidae	**Skat**
Bathyraja andriashevi Dolganev 1985	(M),
Bathyraja tzinovskii Dolganev 1985	(M),
Gurgesiella sibogae (Weber 1913)	(M),
Raja annandalei Weber 1913	(M),
Rhinobatidae	**Guit**
Rhina ancylostoma Bloch & Schneider 1801	Bow M (T Re
Rhinobatos granulatus (Cuvier 1829)	Gran Pc
Rhinobatos halavi (Forsskål 1775)	Hala co
Rhinobatos obtusus (Müller & Henle 1841)	(M),
Rhinobatos schlegelii (Müller & Henle 1841)	Brow
Rhinobatos thouin Anon. 1798	Thou
Rhinobatos typus (Bennett 1830)	Gian M Su
Rhynchobatus australiae Whitley 1939	(M), In
Rhynchobatus djiddensis (Forsskål 1775)	Whit TL C (F

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Myliobatiformes (eagle rays, stingrays and mantas)	
Dasyatidae	**Sting rays**
Dasyatis fluviorum Ogilby 1908	Estuary stingray, (M, Br), Ref. 8630. Max. 130 cm TL.
Dasyatis kuhlii (Müller & Henle 1841)	Blue-spotted stingray, (M, Dan), Ref. 3263. Max. 80 cm TL. Museum. ISH 64/82. From southwest Sumatra to Timor Sea (Ref. 5978).
Dasyatis leylandi Last 1987	Painted maskray, (M), Ref. 9840. Max. 53 cm TL.
Dasyatis zugei (Müller & Henle 1841)	Pale-edged stingray, (M, Br, Fi), Ref. 8630. Max. 29 cm WD.
Himantura alcocki (Annandale 1909)	(M), Ref. 8630
Himantura bleekeri (Blyth 1860)	Bleeker's whipray, (M, Br, Fi, Dan), Ref. 9840. Max. 105 cm WD.
Himantura gerrardi (Gray 1851)	Sharpnose stingray, (M), Ref. 9840. Max. 200 cm TL.
Himantura granulata (Macleay 1883)	Mangrove whipray, (M, Br, Dan), Ref. 8630. Max. 97 cm WD. Known from southern New Guinea and northern Java.
Himantura jenkinsii (Annandale 1909)	Jenkins whipray, (M, Fi), Ref. 8630. Max. 200 cm TL.
Himantura toshi Whitley 1939	Black-spotted whipray, (M), Ref. 9840. Max. 179 cm TL. Known from southern New Guinea.
Himantura uarnak (Forsskål 1775)	Honeycomb stingray, (M, Br, Sport, Dan), Ref. 6871. Max. 200 cm WD. Museum: CSIRO CA1245, from Bali Strait to Timor (Ref. 5978).
Himantura undulata (Bleeker 1852)	Leopard whipray, (M, Dan), Ref. 8630. Max. 410 cm TL.
Himantura walga (Müller & Henle 1841)	Dwarf whipray, (M), Ref. 9840. Max. 40 cm TL.
Hypolophus sephen (Forsskål 1775)	Cowtail stingray, (M, Br, Fr, Fi, Dan), Ref. 7050. Max. 180 cm WD. Museum: CSIRO CA1247 (PW101), Max. 40 cm TL. from southwest Sumatra to Bali Strait (Ref. 5978).
Taeniura lymma (Forsskål 1775)	Ribbontail stingray, (M, Dan), Ref. 6871. Max. 70 cm TL. Museum: ISH 66/82, CSIRO CA1246 (TGT1552), from Bali Strait to Timor (Ref. 5978).
Urogymnus asperrimus (Bloch & Schneider 1801)	Porcupine ray, (M, Br, Dan), Ref. 8630. Max. 300 cm TL.
Gymnuridae	**Butterfly rays**
Gymnura australis (Ramsay & Ogilby 1886)	Australian butterfly ray, (M), Ref. 9918. Max. 56 cm TL. Known from the southern coast of New Guinea. Possibly occurs in the northern coast as well.
Gymnura poecilura (Shaw 1804)	Long-tailed butterfly ray, (M), Ref. 8630. Known from Sumatra, Java, and Borneo (Ref. 9918).
Gymnura zonura (Bleeker 1852)	(M), Ref. 8630. Known from Java (Ref. 9918).
Mobulidae	**Manta rays and devil rays**
Manta birostris (Walbaum 1792)	Giant manta, (M, Br, Dan), Ref. 5978. Max. 700 cm WD.
Mobula diabolus (Shaw 1804)	Devil ray, (M), Ref. 5978. Max. 178 cm WD.
Mobula japanica (Müller & Henle 1841)	Sp
Myliobatidae	**Ea**
Aetobatus flagellum (Bloch & Schneider 1801)	(M
Aetobatus narinari (Euphrasen 1790)	Sp
Aetobatus ocellatus (Kuhl & van Hasselt 1823)	(
Aetomylaeus maculatus (Gray 1834)	Mc
Aetomylaeus milvus (Valenciennes 1838-1841)	(M,
Aetomylaeus nichofii (Bloch & Schneider 1801)	Ba
Aetomylaeus vespertilio (Bleeker 1852)	Orr
Myliobatis tobijei (Bleeker 1854)	Jap
Rhinoptera javanica Müller & Henle 1841	Fla
Urolophidae	**Ro**
Trygonoptera javanica Martens 1864	(M,
Trygonoptera kaiana (Günther 1880)	(M,
Actinopterygii (ray-finned fishes)	
Elopiformes (tarpons and tenpounders)	
Elopidae	**Ter**
Elops hawaiensis Regan 1909	Hav
Elops machnata (Forsskål 1775)	Ten
Megalopidae	**Tar**
Megalops cyprinoides (Broussonet 1782)	Ind
Albuliformes (bonefishes)	
Albulidae	**Bo**
Albula glossodonta (Forsskål 1775)	Rou
Albula neoguinaica Valenciennes 1847	Sha

Table 2. Continuation.
[Tabel 2. Sambungan.]

Anguilla celebensis Kaup 1856	Celebes longfin eel, (M, Br, Fr, Fi), Ref. 7050. Max. 150 cm TL. Sulawesi, Bali, Moluccas, and Irian Jaya.
Anguilla marmorata Quoy & Gaimard 1824	Giant mottled eel, (M, Br, Fr, Fi, Aq, Sport), Ref. 7050. Max. 200 cm TL.
Anguilla nebulosa McClelland 1844	Mottled eel, (M, Br, Fr), Ref. 7050. Max. 121 cm TL. Known from Sumatra.
Congridae	**Conger eels**
Ariosoma anago (Temminck & Schlegel 1846)	(M), Ref. 5978. Max. 60 cm TL. Museum: BMNH 1984.1.1.3. From southwest Sumatra to Timor Sea.
Ariosoma anagoides (Bleeker 1854)	(M), Ref. 559. Max. 51 cm TL.
Ariosoma scheelei (Stromman 1896)	Tropical conger, (M), Ref. 5323. Max. 20 cm TL.
Bathycongrus guttulatus (Günther 1887)	(M), Ref. 5978. Museum: BMNH 1984.1.1.5. From southwest Sumatra to Bali Strait.
Bathymyrus smithi Castle 1968	Maputo conger, (M, Br, Fr), Ref. 5978. Max. 58 cm TL. Museum: BMNH 1984.1.1.4 (PJPW135). From southwest Sumatra to Bali Strait.
Bathyuroconger vicinus (Vaillant 1888)	(M), Ref. 4453. Max. 88 cm TL.
Conger cinereus Rüppell 1828	Longfin African conger, (M), Ref. 583. Max. 130 cm.
Heteroconger hassi (Klausewitz & Eibl-Eibesfeldt 1959)	Spotted garden-eel, Garden eel, (M), Ref. 8631. Max. 35 cm TL. Known from Bali.
Heteroconger perissodon Böhlke & Randall 1981	(M), Ref. 8912. Museum: Molucca Is., Ambon, Poka, ANSP 142731 BPBM 18543, CAS 45889, MNHN 1980-1190, USNM 221380, WAM P26788-001.
Macrocephenchelys brachialis Fowler 1934	(M, Thr), Ref. 245.
Parabathymyrus macrophthalmus Kamohara 1938	(M), Ref. 5978. Max. 47 cm TL. From Bali Strait to Timor Sea.
Rhynchoconger brevirostris Chen & Weng 1967	(M), Ref. 5978. Museum: NMNZ 15178 (TGT1894). From Bali Strait to Timor Sea.
Uroconger lepturus (Richardson 1845)	Slender conger, (M), Ref. 5978. Max. 52 cm TL. Museum: NTM S.10751-001 (TGT1677). From southwest Sumatra to Timor Sea.
Moringuidae	**Worm or spaghetti eels**
Moringua javanica (Kaup 1856)	Java spaghetti eel, (M, Br), Ref. 5501. Max. 90 cm TL. Recorded from Java and Sulawesi. Also Ref.: 7050.
Moringua microchir Bleeker 1853	(M), Ref. 7050. Max. 30 cm TL.
Muraenesocidae	**Pike congers**
Congresox talabon (Cuvier 1829)	Yellow pike conger, (M, Br, Fi), Ref. 7238. Max. 80 cm TL. Recorded from Sulawesi and Lesser Sundas. Also Ref.: 7050.
Congresox talabonoides (Bleeker 1853)	Indian pike conger, (M, Br, Fi), Ref. 7050. Max. 250 cm TL. Recorded from Sulawesi.
Gavialiceps taeniola Alcock 1889	(M), Ref. 5978. Max. 84 cm TL. Museum: BMNH 1984.1.1.6, 1984.1.1.7 (PJPW136). From southwest Sumatra to Bali Strait.
Muraenesox bagio (Hamilton 1822)	Common pike conger, (M, Br, Fi, Dan), Ref. 5978. Max. 200 cm TL. Museum: CSIRO CA1088. From southwest Sumatra to Bali Strait. Also Ref.: 7050.
Muraenesox cinereus (Forsskål 1775)	Da
Muraenidae	**M**
Echidna nebulosa (Ahl 1789)	Sr
Echidna rhodochilus Bleeker 1863	(M
Gymnothorax buroensis (Bleeker 1857)	Va
Gymnothorax chilospilus Bleeker 1865	Lip
Gymnothorax enigmaticus McCosker & Randall 1982	Er
Gymnothorax fimbriatus (Bennett 1832)	Fir
Gymnothorax javanicus (Bleeker 1859)	Gi
Gymnothorax polyuranodon (Bleeker 1853)	(M
Gymnothorax pseudothyrsoideus (Bleeker 1852)	Hi
Gymnothorax reticularis Bloch 1795	(M
Gymnothorax richardsoni (Bleeker 1852)	Ric
Gymnothorax tile (Hamilton 1822)	(M
Gymnothorax undulatus (Lacepède 1803)	Un
Gymnothorax zonipectis Seale 1906	Ba
Pseudechidna brummeri (Bleeker 1858-59)	Wh
Rhinomuraena quaesita Garman 1888	Rib
Siderea picta (Ahl 1789)	Pe
Strophidon sathete (Hamilton 1822)	Sle
Nemichthyidae	**Sn**
Avocettina infans (Günther 1878)	Av
Nemichthys scolopaceus Richardson 1848	Sle
Nettastomatidae	**Du**
Nettenchelys gephyra Castle & Smith 1981	(M

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Ophichthidae	**Snake eels**
Apterichtus klazingai (Weber 1913)	Sharpsnout snake eel, (M), Ref. 3972. Max. 40 cm TL.
Callechelys catostomus (Schneider & Forster 1801)	(M), Ref. 2334. Max. 85 cm TL.
Lamnostoma mindora (Jordan & Richardson 1908)	(M, Br), Ref. 7050. Max. 40 cm TL. Expected to be present in the area (Ref 7050).
Lamnostoma orientalis (McClelland 1844)	Oriental worm-eel, (M, Br, Bait), Ref. 7050. Max. 30 cm. Reported from Irian Jaya.
Muraenichthys gymnopterus (Bleeker 1853)	(M, Br), Ref. 7050. Max. 26.6 cm TL.
Muraenichthys macropterus Bleeker 1857	Slender snake-eel, (M), Ref. 637. Max. 25 cm TL.
Myrichthys bleekeri Gosline 1951	(M), Ref. 1602. Max. 39.5 cm TL.
Ophichthus bonaparti (Kaup 1856)	(M), Ref. 3972. Max. 75 cm TL.
Ophichthus macrochir (Bleeker 1853)	(M, Br), Ref. 7050. Max. 51 cm TL. Known from Sumatra and Java.
Ophichthus urolophus (Temminck & Schlegel 1846)	(M), Ref. 5978. Max. 60 cm TL. Museum: NTM S.10750-001 (TGT1444). From Bali Strait to Timor Sea.
Pisodonophis boro (Hamilton 1822)	Rice-paddy eel, (M, Br, Fr, Fi), Ref. 7050. Max. 100 cm TL. Known from Sumatra, Java, Sulawesi and Moluccas.
Pisodonophis cancrivorus (Richardson 1848)	Longfin snake-eel, (M, Br, Fr, Fi), Ref. 5978. Max. 100 cm TL. Museum: BMNH 1984.1.1.8 (PJPW63). From southwest Sumatra to Bali Strait Bangka, Sulawesi, and Moluccas (Ref. 7050).
Pisodonophis hypselopterus (Bleeker 1851)	(M, Br, Fr), Ref. 7050. Max. 75 cm TL. Recorded from Borneo.
Synaphobranchidae	**Cutthroat eels**
Dysomma anguillare Barnard 1923	Shortbelly eel, (M), Ref. 5978. Max. 52 cm TL. Museum: NTM S.10745-001 (TGT1895). From Bali Strait to Timor Sea.
Clupeiformes (herrings)	
Chirocentridae	**Wolf herring**
Chirocentrus dorab (Forsskål 1775)	Dorab wolf-herring, (M, Fi), Ref. 188. Max. 100 cm SL. Museum: LPPL JIF4 (TGT2222). Found from southwest Sumatra to Timor Sea (Ref. 5978).
Chirocentrus nudus (Swainson 1839)	Whitefin wolf-herring, (M, Fi), Ref. 188. Max. 100 cm SL.
Clupeidae	**Herrings, shads, sardines, menhadens**
Amblygaster clupeoides Bleeker 1849	Bleeker smoothbelly sardinella, (M, Fi, Bait), Ref. 188. Max. 17 cm SL.
Amblygaster leiogaster (Valenciennes 1847)	Smoothbelly sardinella, (M, Fi), Ref. 188. Max. 23 cm SL. Found from southwest Sumatra to Bali Strait (Ref. 5978).
Amblygaster sirm (Walbaum 1792)	Spotted sardinella, Sardin, (M, Fi, Bait), Ref. 188. Max. 23 cm SL. Found from southwest Sumatra to Timor Sea. Museum: NTM S.11000-005 (TGT2382) (Ref. 5978).
Anodontostoma chacunda (Hamilton 1822)	Chi - i
Anodontostoma selangkat (Bleeker 1852)	Ind N
Anodontostoma thailandiae Wongratana 1983	Tha S
Dussumieria acuta Valenciennes 1847	Rai A
Dussumieria elopsoides Bleeker 1849	Sle N (T
Escualosa thoracata (Valenciennes 1847)	Wh S F A
Herklotsichthys dispilonotus (Bleeker 1852)	Bla S
Herklotsichthys gotoi Wongratana 1983	Got
Herklotsichthys quadrimaculatus (Rüppell 1837)	Blu S (T
Hilsa kelee (Cuvier 1829)	Kel S F 5
Ilisha elongata (Bennett 1830)	Elo S
Ilisha filigera (Valenciennes 1847)	Cor S
Ilisha kampeni (Weber & de Beaufort 1913)	Kar K
Ilisha macrogaster Bleeker 1866	Kali K
Ilisha megaloptera (Swainson 1839)	Big S (I
Ilisha melastoma (Schneider 1801)	Indi N s S
Ilisha pristigastroides (Bleeker 1852)	Java N
Ilisha sirishai Seshagiri Rao 1975	Lob
Nematalosa come (Richardson 1846)	Wes N
Opisthopterus tardoore (Cuvier 1829)	Tarc F F 597

Table 2. Continuation.
[Tabel 2. Sambungan.]

Opisthopterus valenciennesi Bleeker 1872	Slender tardoor, (M, Br, Fi), Ref. 188. Max. 20 cm SL. Known from Sumatra, Kalimantan, and Java (Ref. 7050).
Pellona ditchela Valenciennes 1847	Indian pellona, (M, Br, Fr, Fi, Bait), Ref. 188. Max. 16 cm SL. Also Ref.: 6567, 7050. Museum: NTM S.10734-020 (TGT1226). From southwest Sumatra to Timor Sea (Ref. 5978).
Raconda russeliana Gray 1831	Raconda, (M, Br, Fi), Ref. 188. Max. 19 cm SL. Sumatra, Kalimantan, and Java (Ref. 7050).
Sardinella albella (Valenciennes 1847)	White sardinella, (M, Fi), Ref. 188. Max. 14 cm SL.
Sardinella atricauda (Günther 1868)	Bleeker's blacktip sardinella, (M, Fi), Ref. 188. Max. 12.6 cm SL.
Sardinella brachysoma Bleeker 1852	Deepbody sardinella, (M, Fi), Ref. 188. Max. 13 cm SL. Museum: NTM S.10733-023 (TGT1228). Found from southwest Sumatra to Timor Sea (Ref. 5978).
Sardinella gibbosa (Bleeker 1849)	Goldstripe sardinella, Tembang, (M, Fi), Ref. 188. Max. 17 cm SL. Museum: NTM S.10733-024 (TGT2110). Found from southwest Sumatra to Timor Sea (Ref. 5978).
Sardinella lemuru Bleeker 1853	Bali sardinella, Lemuru, (M, Fi), Ref. 188. Max. 23 cm SL. Strait of Bali, south of Ternate and Djakarta Bay and off Central Java. Fished during rainy season with ca. 15-20 days/mo. active fishing with 'payang besar' or 'djala oras' seine nets. Museum: NTM S.10733-032 (TGT1255) (Ref. 5978).
Sardinella melanura (Cuvier 1829)	Blacktip sardinella, (M, Fi, Bait), Ref. 188. Max. 12.2 cm SL.
Spratelloides delicatulus (Bennett 1831)	Delicate round herring, (M, Fi, Bait), Ref. 188. Max. 7 cm SL.
Spratelloides gracilis (Temminck & Schlegel 1846)	Silverstriped round herring, (M, Fi, Bait), Ref. 188. Max. 9.5 cm SL.
Spratelloides lewisi Wongratana 1983	Lewis' round herring, (M, Fi, Bait), Ref. 188. Max. 6 cm SL.
Tenualosa macrura (Bleeker 1852)	Longtail shad, (M, Br, Fr, Fi), Ref. 188. Max. 52 cm SL. Also Ref.: 7050.
Tenualosa toli (Valenciennes 1847)	Toli shad, (M, Br, Fr, Fi), Ref. 188. Max. 50 cm SL. Also Ref.: 7050.
Engraulidae	**Anchovies**
Coilia borneensis Bleeker 1852	Bornean grenadier anchovy, (M, Br, Fr), Ref. 189. Max. 12.4 cm SL. Reported from Sumatra and Kalimantan (Ref. 7050).
Coilia coomansi Hardenberg 1934	Cooman's grenadier anchovy, (M, Br, Fi), Ref. 189. Max. 12.3 cm SL. Reported from Sumatra and Kalimantan (Ref. 7050).
Coilia dussumieri Valenciennes 1848	Goldspotted grenadier anchovy, (M, Br, Fi), Ref. 189. Max. 20 cm SL. Known from Sumatra and Java (Ref. 7050).
Coilia macrognathos Bleeker 1852	Longjaw grenadier anchovy, (M, Br, Fi), Ref. 189. Max. 26 cm SL. Known from Kalimantan (Ref. 7050).
Coilia neglecta Whitehead 1968	Neglected grenadier anchovy, (M, Br, Fi), Ref. 189. Max. 17 cm SL. Known from Kalimantan (Ref. 7050).
Coilia rebentischii	Many-fingered grenadier anchovy, (M, Br, Fi), Ref. 189.

Bleeker 1849	
Encrasicholina devisi (Whitley 1940)	De
Encrasicholina heteroloba (Rüppell 1837)	Sh
Encrasicholina punctifer Fowler 1938	Bu
Engraulis japonicus Temminck & Schlegel 1846	Ja
Papuengraulis micropinna Munro 1964	Lit
Setipinna breviceps (Cantor 1850)	Sh
Setipinna melanochir (Bleeker 1849)	Du
Setipinna taty (Valenciennes 1848)	Sc
Setipinna tenuifilis (Valenciennes 1848)	Co
Stolephorus andhraensis Babu Rao 1966	An
Stolephorus baganensis Hardenberg 1933	Ba
Stolephorus carpentariae (De Vis 1882)	Gu
Stolephorus commersonii Lacepède 1803	Co
Stolephorus dubiosus Wongratana 1983	Th
Stolephorus indicus (van Hasselt 1823)	Inc
Stolephorus insularis Hardenberg 1933	Ha
Stolephorus tri (Bleeker 1852)	Sp
Stolephorus waitei Jordan & Seale 1926	Sp
Thryssa baelama (Forsskål 1775)	Ba
Thryssa dussumieri (Valenciennes 1848)	Du
Thryssa encrasicholoides (Bleeker 1852)	Fa
Thryssa hamiltonii (Gray 1830)	Ha

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Thryssa kammalensis (Bleeker 1849)	Kammal thryssa, (M, Br, Fi), Ref. 189. Max. 8.3 cm SL.
Thryssa mystax (Schneider 1801)	Moustached thryssa, (M, Br, Fi), Ref. 189. Max. 15.5 cm SL. Museum: NTM S.10733-038. Found from southwest Sumatra to Timor Sea (Ref. 5978). Also Ref.: 7050.
Thryssa setirostris (Broussonet 1782)	Longjaw thryssa, (M, Br, Fi, Bait), Ref. 189. Max. 18 cm SL. Museum: LPPL JIF3 (TGT2171). Found from southwest Sumatra to Timor Sea (Ref. 5978). Also Ref.: 7050.
Gonorynchiformes (milkfish)	
Chanidae	**Milkfish**
Chanos chanos (Forsskål 1775)	Milkfish, Bandeng, (M, Br, Fi, Aq, Bait), Ref. 49. Max. 180 cm. Also Ref.: 7050, 8631, 9987 and 8984. Museum: LPPL JIF8 (TGT1088). Found from Bali Strait to Timor Sea (Ref. 5978).
Siluriformes (catfish)	
Ariidae	**Sea catfishes**
Arius argyropleuron Valenciennes 1840	Sharp-headed catfish, (M, Br, Dan), Ref. 7050. Max. 46 cm TL. Sumatra, Kalimantan, and Java.
Arius bilineatus (Valenciennes 1840)	Bronze catfish, (M, Br, Dan), Ref. 7050. Max. 60 cm SL. Sumatra, Kalimantan, and Java.
Arius caelatus Valenciennes 1840	Engraved catfish, (M, Br, Fi, Dan), Ref. 3290. Max. 45 cm TL. Sumatra, Kalimantan, and Java (Ref. 7050).
Arius crossocheilos Bleeker 1846	Roughback sea catfish, (M, Br, Fi, Dan), Ref. 5978. Max. 40 cm. Museum: NTM S.10733-030 (TGT2121). From Bali Strait to Timor Sea.
Arius leptaspis (Bleeker 1862)	Salmon catfish, (M, Br, Fr, Sport), Ref. 4537. Max. 50 cm SL.
Arius leptonocanthus Bleeker 1849	(M, Br), Ref. 7050. Max. 21.1 cm TL.
Arius maculatus (Thunberg 1792)	Spotted catfish, (M, Br, Fi, Dan), Ref. 3279. Max. 60 cm TL. Museum: NTM S.11030-002 (TGT2202). Found from southwest Sumatra to Bali Strait (Ref. 5978).
Arius nella (Valenciennes 1840)	(M, Br), Ref. 7050. Max. 47 cm TL. Known from Sumatra, Java and Sulawesi.
Arius oetik Bleeker 1846	(M, Br), Ref. 7050. Max. 22.5 cm TL. Known from western Borneo and Java.
Arius polystaphylodon Bleeker 1846	Mozambique sea catfish, (M, Br, Fr), Ref. 7050. Max. 35 cm SL. Sumatra, Kalimantan, and Java.
Arius sagor (Hamilton 1822)	Sagor catfish, (M, Br, Fi, Dan), Ref. 3279. Max. 45 cm TL. Sumatra, Kalimantan, and Java (Ref. 7050).
Arius stormii (Bleeker 1858)	(M, Br), Ref. 7050. Max. 50 cm TL. Known from Sumatra and Borneo.
Arius subrostratus Valenciennes 1840	Shovelnose sea catfish, (M, Br, Fr, Fi, Dan), Ref. 3290 Max. 32 cm. Sumatra, Kalimantan, Madura, Banka, and Java.
Arius sumatranus (Bennett 1830)	Goat catfish, (M, Br, Fr, Fi, Dan), Ref. 3290. Max. 32 cm. Sumatra, Madura, Kalimantan, Banka, and Java.
Arius truncatus Valenciennes 1840	(M, Br), Ref. 7050. Max. 33 cm TL.
Arius venosus	Veined catfish, (M, Br, Fi, Dan), Ref. 3279.

Valenciennes 1840	Max 7
Batrachocephalus mino (Hamilton 1822)	Beard Max 705
Cephalocassis melanochir (Bleeker 1852)	(M, Br Ma
Hemipimelodus borneensis (Bleeker 1851)	(M, Br Ma
Ketengus typus Bleeker 1857	(M, Br Ma Jav
Netuma thalassina (Rüppell 1837)	Giant Als Fro
Osteogeneiosus militaris (Linnaeus 1758)	Soldie TL.
Plotosidae	**Eelta**
Euristhmus lepturus (Günther 1864)	Long- Ma
Paraplotosus albilabris (Valenciennes 1840)	White Ma
Plotosus canius	Gray Ha Ja
Plotosus lineatus (Thunberg 1787)	Stripe Ma Fo Als
Salmoniformes (salmons, pikes and smelts)	
Alepocephalidae	**Slick**
Alepocephalus bicolor Alcock 1891	(M), I
Microphotolepis multipunctata Sazonov & Parin 1977	(M), I (P.
Xenodermichthys copei (Gill 1884)	Blunt Ma (P
Bathylagidae	**Deep**
Bathylagus argyrogaster Norman 1930	(M), 19 Su
Microstomatidae	
Xenophthalmichthys danae Regan 1925	(M),
Stomiiformes (lightfishes and dragonfishes)	
Astronesthidae	**Sna**
Astronesthes chrysophekadion (Bleeker 1849)	(M), Fr
Astronesthes cyaneus (Brauer 1902)	(M), M pa Fr
Astronesthes indicus Brauer 1902	(M), B

Table 2. Continuation.
[Tabel 2. Sambungan.]

	From southwest Sumatra to Bali Strait.
Astronesthes martensii Klunzinger 1871	(M), Ref. 5978. Max. 14 cm TL. Museum: BMNH 1984. 1.1.22 (TGT (PJPW) 774). From southwest Sumatra to Timor Sea.
Astronesthes splendidus Brauer 1902	(M), Ref. 5978. From southwest Sumatra to Bali Strait.
Chauliodontidae	**Viperfishes**
Chauliodus sloani Schneider 1801	Sloane's viperfish, (M), Ref. 5978. Max. 35 cm SL. Museum: AMS I.24338-001 (TGT1672). From southwest Sumatra to Bali Strait.
Gonostomatidae	**Bristlemouths or lightfishes**
Diplophos greyae Johnson 1970	(M), Ref. 5978. Museum: BMNH 1984.1.1.17 (TGT (PJPW) 839). From southwest Sumatra to Bali Strait.
Gonostoma elongatum Günther 1878	Elongated bristlemouth fish, (M), Ref. 5978. Max. 27.5 cm TL. Museum: BMNH 1984.1.1.23 (PJPW116), from southwest Sumatra to Bali Strait.
Malacosteidae	**Loosejaws**
Malacosteus niger Ayres 1848	(M), Ref. 4469. Max. 21.6 cm SL.
Melanostomiidae	**Scaleless black dragonfishes**
Echiostoma barbatum Lowe 1843	(M), Ref. 5978. Max. 36.8 cm SL. From southwest Sumatra to Bali Strait.
Eustomias bifilis Gibbs 1960	(M), Ref. 5978. From southwest Sumatra to Bali Strait.
Melanostomias macrophotus Regan & Trewavas 1930	(M), Ref. 5978 Max. 22.9 cm SL. Museum: BMNH 1984.1.1.25 (PJPW 42 in part). From southwest Sumatra to Bali Strait.
Melanostomias valdiviae Brauer 1902	Valdivia black dragon fish, (M), Ref. 4468. Max. 23.2 cm SL. West coast of Sumatra.
Photonectes albipennis (Döderlein 1882)	(M), Ref. 5978. Museum: BMNH 1984.1.1.27 (PJPW) 42 in part). From southwest Sumatra to Bali Strait.
Phosichthyidae	**Lightfishes**
Pollichthys mauli	(M), Ref. 5978. Max. 6 cm SL. Museum: BMNH 1984.1.1.13 (Poll 1953) (PJPW) 2031).From southwest Sumatra to Bali Strait.
Polymetme corythaeola (Alcock 1898)	(M), Ref. 5978. Max. 26 cm SL. Museum: BMNH 1984.1.1.14 (PJPW205). From southwest Sumatra to Bali Strait.
Sternoptychidae	
Argyripnus brocki Struhsaker 1973	Brock's bristle-mouth fish, (M), Ref. 5978. Museum: AMS I.24338-002 (TGT1676). From Bali Strait to Timor Sea.
Maurolicus muelleri (Gmelin 1789)	Pearlsides, (M, Fi), Ref. 5978. Max. 6.5 cm SL. Museum: BMNH 1984.1.1.19. From southwest Sumatra to Bali Strait.
Polyipnus spinosus (Günther 1887)	(M), Ref. 5282.
Polyipnus tridentifer McCulloch 1914	(M), Ref. 5978. Museum: AMS I.24318-002 (TGT2533). From southwest Sumatra to Bali Strait.
Polyipnus triphanos Schultz 1938	(M), Ref. 5978. Museum: AMS I.24338-001 (TGT1672 in part). From Bali Strait to Timor Sea.
Stomiidae	**Scaly dragonfishes**
Stomias nebulosus Alcock 1889	(M), 19 to
Aulopiformes (grinners)	
Alepisauridae	**Lanc**
Alepisaurus ferox Lowe 1833	Long
Chlorophthalmidae	**Gree**
Chlorophthalmus agassizi Bonaparte 1840	Shor M Fc 59
Chlorophthalmus albatrossis Jordan & Starks 1904	(M), 01 St
Chlorophthalmus bicornis Norman 1939	Spin Mu Su
Chlorophthalmus nigromarginatus Kamohara 1953	(M), 01 Se
Chlorophthalmus oblongus Kamohara 1953	(M), . 01
Ipnops agassizii Garman 1899	(M), I Mu
Paralepididae	**Barr**
Lestidiops mirabilis (Ege 1933)	Strar Su
Lestidium atlanticum Borodin 1928	Atlan Mu Su
Lestrolepis intermedia (Poey 1868)	(M), I BM Su
Stemonosudis elegans (Ege 1933)	(M), I 19 Su
Stemonosudis rothschildi Richards 1967	(M), I 19 Ba
Scopelarchidae	**Pear**
Melamphaes danae Ebeling 1962	(M), I
Synodontidae	**Lizar**
Harpadon microchir Günther 1878	(M), I 19 to
Harpadon nehereus (Hamilton 1822)	Bomb Mu Fo
Saurida gracilis (Quoy & Gaimard 1824)	Gr

Table 2. Marine and brackishwater fishes of Indonesia
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Saurida longimanus Norman 1939	Longfin lizardfish, (M), Ref. 5978. Max. 25 cm. Museum: NTM S.10761-005 (TGT3164). From Bali Strait to Timor Sea.
Saurida micropectoralis Shindo & Yamada 1972	Shortfin lizardfish, (M), Ref. 2117. Max. 38 cm. Museum: BMNH 1984.1.1.33 (TGT1325). Found from southwest Sumatra to Timor Sea (Ref. 5978).
Saurida nebulosa Valenciennes 1849	Clouded lizardfish, (M, Br, Fi), Ref. 5978. Max. 18.5 cm FL. Museum: NTM S.10749-001 (TGT1805). From Bali Strait to Timor Sea.
Saurida tumbil (Bloch 1795)	Greater lizardfish, (M, Fi), Ref. 6567. Max. 60 cm FL. Museum: LPPL JIF6 (TGT2384). From southwest Sumatra to Timor Sea.
Saurida undosquamis (Richardson 1848)	Brushtooth lizardfish, (M, Fi), Ref. 6567. Max. 50 cm SL. Museum: LPPL JIF7 (TGT2248). Found from southwest Sumatra to Timor Sea (Ref. 5978).
Saurida wanieso Shindo & Yamada 1972	Wanieso lizardfish, (M), Ref. 5978. Max. 65 cm SL. Museum: NTM S.11029-002 (TGT2253). From southwest Sumatra to Bali Strait. In range Ref.: 559.
Synodus dermatogenys Fowler 1912	Sand lizardfish, (M), Ref. 8631. Max. 18 cm SL. Known from Flores.
Synodus englemani Schultz 1953	(M), Ref. 5978. Museum: NTM S.10758-001 (TGT1877). From Bali Strait to Timor.
Synodus hoshinonis Tanaka 1917	Blackear lizardfish, (M, Fi), Ref. 5978. Max. 20 cm. Museum: USNM 264322 (TGT2535). From southwest Sumatra to Bali Strait.
Synodus indicus (Day 1873)	Indian lizardfish, (M, Fi), Ref. 5978. Max. 20 cm. Museum: USNM 264332 (TGT2602). From southwest Sumatra to Timor Sea.
Synodus jaculum Russell & Cressey 1979	Lighthouse lizardfish, (M, Fi), Ref. 5978. Max. 20 cm TL. Also Ref.: 8631. Museum: NTM S.10744-003. From Bali Strait to Timor Sea.
Synodus kaianus (Günther 1880)	Gunther's lizard fish, (M), Ref. 5978. Max. 30 cm SL. Museum: NTM S.10760-001 (TGT1724). From Bali Strait to Timor Sea.
Synodus macrocephalus Cressey 1981	(M), Ref. 5978. Museum: USNM 235455 (TGT3092). From southwest Sumatra to Timor Sea.
Synodus macrops Tanaka 1917	Triplecross lizardfish, (M, Fi), Ref. 5978. Max. 20 cm. Museum: USNM 235456 (TGT3215). From Bali Strait to Timor Sea.
Synodus oculeus Cressey 1981	(M), Ref. 5978. Museum: NTM S.10743-002 (TGT3162). From Bali Strait to Timor Sea.
Synodus rubromarmoratus Russell & Cressey 1979	Redmarbled lizardfish, (M), Ref. 5978. Max. 12 cm TL. Museum: USNM 264327 (TGT2281B). From southwest Sumatra to Timor Sea.
Synodus sageneus Waite 1905	Speartoothed grinner, (M, Fi), Ref. 3520. Max. 26 cm TL.
Synodus tectus Cressey 1981	(M), Ref. 5978. Museum: NTM S.10740-002 (TGT1632). From Bali Strait to Timor Sea.
Synodus ulae Schultz 1953	Red lizard fish, (M), Ref. 8631. Max. 30 cm SL. Known from Flores.
Synodus usitatus	(M), Ref. 5978.

	Mu:
Cressey 1981	F
Synodus variegatus (Lacepède 1803)	Var N (S
Trachinocephalus myops (Forster 1801)	Sna .
Myctophiformes (lanternfishes)	
Myctophidae	**Lar**
Benthosema fibulatum (Gilbert & Cramer 1897)	Spi N (S
Benthosema pterotum (Alcock 1890)	Ski N F
Benthosema suborbitale (Gilbert 1913)	Sm N
Diaphus chrysorhynchus Gilbert & Cramer 1896	Gol N fi
Diaphus coeruleus (Klunzinger 1871)	(M) 2
Diaphus effulgens (Goode & Bean 1896)	(M) I. T
Diaphus fragilis Tåning 1928	Fra- N S
Diaphus garmani Gilbert 1906	(M) 1 t
Diaphus lucidus (Goode & Bean 1896)	(M) 1 S
Diaphus signatus Gilbert 1908	(M) s 4
Diaphus splendidus (Brauer 1904)	(M) C
Diaphus suborbitalis Weber 1913	(M) 1
Diaphus thiollieri Fowler 1934	(M)
Diaphus watasei Jordan & Starks 1904007.	(M) F
Lampadena luminosa (Garman 1899)	(M) 1 S
Lampanyctus lineatus Tåning 1928	(M) 1 S
Myctophum asperum	Pric

Table 2. Continuation.
[Tabel 2. Sambungan.]

Richardson 1845	Museum: BMNH 1984.1.1.43TGT(PJPW)436). From southwest Sumatra to Bali Strait.
Myctophum brachygnathum (Bleeker 1856)	Short-jawed lanternfish, (M), Ref. 5978. Museum: BMNH 1984.1.1.44 (PJPW 120 in part). From southwest Sumatra to Timor Sea. RMNH 6932 (syntypes, 2), Makassar.
Notoscopelus resplendens (Richardson 1845)	Patchwork lampfish, (M), Ref. 5978. Max. 9.5 cm SL. Museum: BMNH 1984.1.1.46 (PJPW 120 in part). From southwest Sumatra to Bali Strait.
Scopelopsis multipunctatus	(M), Ref. 5978 Brauer 1906. Max. 8.1 cm SL. Museum: BMNH 1984.1.1.47 (PJPW 120 in part). From southwest Sumatra to Bali Strait.
Lampriformes (velifers, tube-eyes and ribbonfishes)	
Megalomycteridae	**Largenose fishes**
Ataxolepis apus Myers & Friehofer 1966	(M), Ref. 9844.
Trachipteridae	**Ribbonfishes**
Desmodema polystictum (Ogilby 1897)	Polka-dot ribbonfish, (M), Ref. 5978. Max. 110 cm TL. Museum: NTM S.11036-001 (TGT1560). From Bali Strait to Timor Sea.
Trachipterus trachypterus (Gmelin 1789)	Ribbon fish, (M), Ref. 5978. Max. 300 cm TL. Museum: BMNH 1984.1.1.62 (TGT (PJPW) 834). From southwest Sumatra to Bali Strait.
Veliferidae	**Velifers**
Velifer hypselopterus Bleeker 1879	Sailfin velifer, (M), Ref. 5978. Max. 40 cm SL. Museum: WAM P.26194-010.From Bali Strait to Timor Sea, though the lateral line count (59-63) of this material is consistenly below that stated for the species (70-72).
Ophidiiformes (cusk eels)	
Carapidae	**Pearlfishes**
Encheliophis gracilis (Bleeker 1856)	Graceful pearlfish, (M), Ref. 4104. Max. 30 cm SL. Banda Islands, type locality.
Pyramodon ventralis Smith & Radcliffe 1913	(M), Ref. 559
Ophidiidae	**Cusk-eels**
Glyptophidium macropus Alcock 1894	(M), Ref. 5978. Museum: ZMUC P77737 (TGT1448). From Bali Strait to Timor Sea.
Glyptophidium oceanicum Smith & Radcliffe 1913	(M), Ref. 5978. Max. 22 cm SL. Museum: ZMUC P77751 (TGT2518). From southwest Sumatra to Bai Strait.
Homostolus acer Smith & Radcliffe 1913	(M), Ref. 6225. Max. 18.4 cm SL. Museum: BSKU 16704, 16678; MNHN 1984-640.
Hypopleuron caninum Smith & Radcliffe 1913	(M), Ref. 5978. Museum: ZMUC P77752 (TGT2519). From southwest Sumatra to Bali Strait.
Lamprogrammus brunswigi (Brauer 1906)	(M), Ref. 3686. Max. 90 cm. Museum: USNM 74146 (Holotype, Buton Strait, Indonesia).
Neobythites longipes Smith & Radcliffe 1913	(M), Ref. 5978. Museum: ZMUC P77740 (TGT1718). From Bali Strait to Timor Sea.
Neobythites macrops Günther 1887	(M), Ref. 5978. Museum: BMNH 1983.1.1.57 (TGT (PJPW) 453). From southwest Sumatra to Bali Strait.
Neobythites malayanus Weber 1913	(M), Ref. 5978. Museum: ZMUC P77742 (TGT1897). From Bali

Ophidion muraenolepis (Günther 1880)	(M
Sirembo jerdoni (Day 1888)	Brc
Gadiformes (cods)	
Bregmacerotidae	**Co**
Bregmaceros atlanticus Goode & Bean 1886	An
Bregmaceros lanceolatus Shen 1960	(M
Bregmaceros mcclellandi Thompson 1840	Sp
Bregmaceros nectabanus Whitley 1941	(M
Macrouridae	**Gr**
Caelorinchus argentatus Smith & Radcliffe 1912	Sil
Caelorinchus argus Weber 1913	Ey
Cetonurus globiceps (Vaillant 1888)	(M
Malacocephalus laevis (Lowe 1843)	So
Ventrifossa divergens Gilbert & Hubbs 1920	Pla
Ventrifossa nigrodorsalis Gilbert & Hubbs 1920	Sp
Ventrifossa petersoni (Alcock 1891)	Pe
Moridae	**Moric**
Physiculus nigrescens Smith & Radcliffe 1912	(M
Tripterophycis gilchristi Boulenger 1902	Gr
Batrachoidiformes (toadfishes)	
Batrachoididae	**To**
Batrachomoeus trispinosus (Günther 1861)	Three Kn
Halophryne diemensis (LeSueur 1824)	Band
Lophiiformes (anglerfishes)	
Antennariidae	**Frog**
Antennarius biocellatus (Cuvier 1817)	Brack Ma
Antennarius coccineus	Scarl

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

(Lesson 1830)	
Antennarius commersoni (Latreille 1804)	Commerson's frogfish, (M), Ref. 5978. Max. 29.1 cm SL. Museum: LPPL JIF10 (TGT1770). From Bali Strait to Timor Sea.
Antennarius dorehensis Bleeker 1859	New Guinean frogfish, (M), Ref. 6773. Max. 5.1 cm SL.
Antennarius hispidus (Bloch & Schneider 1801)	Shaggy angler, (M), Ref. 5978. Max. 20 cm TL. Museum: CSIRO CA1689. From Bali Strait to Timor Sea.
Antennarius maculatus (Desjardins 1840)	Warty frogfish, (M), Ref. 6773. Max. 9 cm.
Antennarius nummifer (Cuvier 1817)	Spotfin frogfish, (M), Ref. 6773. Max. 10 cm SL.
Antennarius pictus (Shaw & Nodder 1794)	Painted angler, (M), Ref. 5978. Max. 30 cm TL. From Bali Strait to Timor Sea. In range Ref.: 4113.
Antennarius randalli Allen 1970	Randall's frogfish, (M), Ref. 1602. Max. 2.1 cm SL.
Antennarius striatus (Shaw & Nodder 1794)	Striated frogfish, (M, Br), Ref. 6773. Max. 22 cm.
Antennatus tuberosus (Cuvier 1817)	Tuberculated frogfish, (M, Dan), Ref. 6773. Max. 7 cm SL.
Histrio histrio (Linnaeus 1758)	Sargassumfish, (M), Ref. 6773. Max. 20 cm TL.
Chaunacidae	**Sea toads**
Chaunax fimbriatus Hilgendorf 1879	(M), Ref. 5978. Max. 14 cm SL. Museum: NTM S.10998-010 (TGT2531). From southwest Sumatra to Timor Sea.
Gigantactinidae	
Gigantactis perlatus Beebe & Crane 1947	(M), Ref. 559
Lophichthyidae	**Lophichthyid frogfishes**
Lophichthys boschmai Boeseman 1964	(M, En), Ref. 245.
Lophiidae	**Goosefishes**
Lophiodes gracilimanus (Alcock 1899)	(M), Ref. 5978. Museum: BMNH 1984.1.1.53. From southwest Sumatra to Bali Strait.
Lophiodes mutilus (Alcock 1894)	Smooth angler, (M), Ref. 5978. Max. 45 cm. Museum: BMNH 1984.1.1.54 (PJPW2035). From southwest Sumatra to Bali Strait. In range Ref.: 3461.
Lophiomus setigerus (Vahl 1797)	Blackmouth angler, (M), Ref. 5978. Max. 40 cm. From southwest Sumatra to Timor Sea.
Ogcocephalidae	**Batfishes**
Halieutaea coccinea Alcock 1889	(M), Ref. 5978. Museum: NTM S.11117-002. From southwest Sumatra to Bali Strait.
Halieutaea fumosa Alcock 1894	(M), Ref. 5978. Max. 14 cm SL. Museum: NTM S. 10761-010 (TGT3152). From Bali Strait to Timor Sea.
Halieutaea indica Annandale & Jenkins 1910	Indian handfish, (M), Ref. 5978. Museum: NTM S.11001-005 (TGT2556). From southwest Sumatra to Bali Strait.
Halieutaea stellata (Vahl 1797)	Starry handfish, (M), Ref. 5978. Max. 30 cm TL. Museum: NTM S.10995-005 (TGT2556). From southwest Sumatra to Timor Sea.
Malthopsis luteus Alcock 1891	(M), Ref. 5978.Max. 6 cm SL. Museum: NTM S.10760-013 (TGT1711). From Bali Strait to Timor Sea.
Tetrabrachiidae	
Tetrabrachium ocellatum Günther 1880	(M), F
Atheriniformes (silversides)	
Atherinidae	**Silve**
Atherinomorus cylindricus (Valenciennes 1835)	Waig Fo
Atherinomorus duodecimalis (Valenciennes 1835)	Tropic Kn
Atherinomorus lineatus (Günther 1872)	Line s Re
Atherion elymus Jordan & Starks 1901	Beard
Dentatherina merceri Patten & Ivantsoff 1983	Merce SL
Hypoatherina barnesi Schultz 1953	Barne
Hypoatherina ovalaua (Herre 1935)	Fijian
Hypoatherina valenciennei (Bleeker 1853)	Suma
Kalyptatherina helodes (Ivantsoff & Allen 1984)	Marin Ma
Pseudomugil inconspicuus Roberts 1978	Incon Ma
Stenatherina panatela (Jordan & Richardson 1908)	Pana TL
Beloniformes (needle fishes)	
Belonidae	**Need**
Strongylura urvillii (Valenciennes 1846)	(M, B
Tylosurus crocodilus crocodilus (Peron & Lesueur 1821)	Houn Ma
Tylosurus punctulatus (Günther 1872)	(M), F
Exocoetidae	**Flyin**
Cheilopogon arcticeps (Günther 1866)	(M), F
Cheilopogon katoptron (Bleeker 1866)	(M), F
Cypselurus hexazona (Bleeker 1853)	(M), F
Cypselurus oligolepis (Bleeker 1866)	(M, F
Cypselurus opisthopus (Bleeker 1866)	Black SL
Cypselurus poecilopterus (Valenciennes 1847)	Yello
Hirundichthys oxycephalus (Bleeker 1852)	Bony
Hemiramphidae	**Halfb**
Hemiramphus archipelagicus Collette & Parin 1978	Jump
Hemiramphus lutkei Valenciennes 1847	Lutke
Hyporhamphus balinensis	(M),

Table 2. Continuation.
[Tabel 2. Sambungan.]

(Bleeker 1859)	
Hyporhamphus dussumieri (Valenciennes 1846)	Dussumier's halfbeak, (M), Ref. 9843. Max. 29.8 cm SL.
Hyporhamphus melanopterus Collette & Parin 1978	(M), Ref. 9843. Max. 17 cm SL.
Hyporhamphus neglectissimus Parin, Collette & Schcherbachev 1980	(M), Ref. 9843. Max. 14.4 cm SL. Irian Jaya.
Hyporhamphus neglectus (Bleeker 1866)	(M), Ref. 9843. Max. 16.5 cm SL.
Hyporhamphus quoyi (Valenciennes 1847)	Quoy's garfish, (M, Br, Fr), Ref. 9843. Max. 31.2 cm SL.
Oxyporhamphus convexus convexus (Weber & de Beaufort 1922)	(M), Ref. 9843.
Oxyporhamphus micropterus micropter (Valenciennes 1847)	Bigwing halfbeak, (M), Ref. 9843. Max. 18.5 cm SL.
Rhynchorhamphus georgii (Valenciennes 1847)	Long billed half beak, (M), Ref. 9843.
Zenarchopterus buffonis (Valenciennes 1847)	(M, Br), Ref. 7050. Max. 12.5 cm SL.
Zenarchopterus rasori (Popta 1912)	(M), Ref. 10988. Muna Island, Celebes.
Beryciformes (sawbellies)	
Anomalopidae	**Lanterneye fishes**
Anomalops katoptron (Bleeker 1856)	Splitfin flashlightfish, (M), Ref. 5004. Max. 35 cm.
Photoblepharon palpebratus palpebra (Boddaert 1781)	Eyelight fish, (M), Ref. 5004. Max. 12 cm. Also Ref.: 1602, 4537, 8631.
Anoplogastridae	**Fangtooth**
Anoplogaster cornuta (Valenciennes 1833)	Common fangtooth, (M), Ref. 4737. Max. 15.2 cm SL.
Diretmidae	**Spinyfins**
Diretmoides veriginae Kotlyar 1987	(M), Ref. 9927. Max. 23.3 cm SL.
Holocentridae	**Squirrelfishes, soldierfishes**
Myripristis adusta Bleeker 1853	Shadowfin soldierfish, (M), Ref. 5300. Max. 33 cm.
Myripristis amaenus (Castelnau 1873)	Brick soldierfish, (M), Ref. 1602. Max. 26 cm TL.
Myripristis berndti Jordan & Evermann 1903	Blotcheye soldierfish, (M), Ref. 5378. Max. 30 cm TL. Museum: BPBM 29389 (TGT2190). Found from southwest Sumatra to Timor Sea (Ref. 5978).
Myripristis hexagona (Lacepède 1802)	Blacktip soldierfish, (M), Ref. 5300.Max. 30 cm.
Myripristis kuntee Cuvier 1831	Pearly soldierfish, (M), Ref. 5300. Max. 17 cm SL. Also Ref.: 8631. Museum: BPBM 29388 (TGT2180). Found from Bali Strait to Timor Sea (Ref. 5978).
Myripristis melanosticta Bleeker 1863	Splendid squirrelfish, (M), Ref. 5378. Max. 30 cm TL. Museum: CSIRO CA1545. From Bali Strait to Timor Sea (Ref. 5978).
Myripristis murdjan (Forsskål 1775)	Pinecone soldierfish, (M, Dan), Ref. 5300. Max. 30 cm. Also Ref.: 8631. Museum: LPPL JIF12 (PAN9). Found from Bali Strait to Timor Sea (Ref. 5978).
Myripristis parvidens Cuvier 1829	Small-eyed squirrelfish, (M), Ref. 5300. Max. 17.3 cm SL.
Myripristis pralinia Cuvier 1829	Scarle Also
Myripristis trachyacron Bleeker 1863	(M), R
Myripristis violacea Bleeker 1851	Lattice fron
Myripristis vittatus Valenciennes 1831	Whitet Knc
Neoniphon argenteus (Valenciennes 1831)	Clearf Knc
Neoniphon opercularis (Valenciennes 1831)	Black Mu: Tim
Neoniphon sammara (Forsskål 1775)	Samm Ma:
Ostichthys acanthorinus Ahl 1923	(M), F 26 Sea
Ostichthys japonicus (Cuvier 1829)	(M), F (TG
Ostichthys kaianus (Günther 1880)	Deepv
Sargocentron caudimaculatum (Rüppell 1838)	Silvers Ma:
Sargocentron cornutum (Bleeker 1853)	Three Ma:
Sargocentron diadema (Lacepède 1801)	Crowr Als (TG Stra
Sargocentron melanospilos (Bleeker 1858)	Blacks TL.
Sargocentron punctatissimum (Cuvier 1829)	Speck Mu Tim
Sargocentron rubrum (Forsskål 1775)	Redcc Ref Bal
Sargocentron spiniferum (Forsskål 1775)	Sabre Mu Sur
Sargocentron violaceum (Bleeker 1853)	Violet Knc
Melamphaidae	**Bigsc**
Melamphaes eulepis Ebeling 1962	(M), F
Poromitra oscitans Ebeling 1975	(M), F
Scopelogadus mizolepis mizolepis (Günther 1878)	(M), F BM Frc 42
Monocentridae	**Pinec**
Monocentris japonica	Pinec

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

(Houttuyn 1782)	Museum: CSIRO CA1807. From southwest Sumatra to Timor Sea.
Trachichthyidae	**Slimeheads**
Aulotrachichthys latus (Fowler 1938)	(M), Ref. 5978. Museum: CSIRO CA1545. From Bali Strait to Timor Sea.
Hoplostethus melanopus (Weber 1913)	(M), Ref. 4181. Max. 25 cm TL.
Hoplostethus rubellopterus Kotlyar 1980	(M), Ref. 9872.
Hoplostethus shubnikovi Kotlyar 1980	(M), Ref. 9872.
Zeiformes (dories)	
Caproidae	**Boarfishes**
Antigonia capros Lowe 1843	Deepbody boarfish, (M), Ref. 5978. Max. 30 cm SL. Museum: NTM S.10760-015 (TGT1742). From southwest Sumatra to Timor Sea.
Antigonia malayana Weber 1913	(M), Ref. 5978. Museum: NTM S.11034-002 (TGT2330). From southwest Sumatra to Timor Sea.
Antigonia rubescens (Günther 1860)	Indo-Pacific boarfish, (M), Ref. 5978. Max. 22 cm TL. Museum: NTM S.11116-004.From southwest Sumatra to Timor Sea.
Macrurocyttidae	
Cyttula macropus Weber 1913	(M), Ref. 6543. Max. 6.8 cm TL. Specimens collected from Flores Sea.
Oreosomatidae	**Oreos**
Allocyttus verrucosus (Gilchrist 1906)	Warty oreo, (M), Ref. 6545. Max. 42 cm.
Zeidae Dories	
Cyttopsis cypho (Fowler 1934)	(M), Ref. 5978. Museum: NTM S.10998-011 (TGT2529). From southwest Sumatra to Timor Sea.
Zenopsis conchifer (Lowe 1852)	Silvery John dory, (M), Ref. 5978. Max. 70 cm TL. Museum: LPPL JIF16 (TGT(PJPW)390). From southwest Sumatra to Bali Strait.
Zenopsis nebulosus (Temminck & Schlegel 1847)	Mirror dory, (M, Fi), Ref. 5978. Max. 70 cm. Museum: NTM S.10752-010 (TGT3229). From Bali Strait to Timor Sea.
Gasterosteiformes (sticklebacks and seamoths)	
Pegasidae	**Seamoths**
Eurypegasus draconis (Linnaeus 1766)	Short dragonfish, (M, Br), Ref. 1418. Max. 10 cm TL. Known from Sumatra and Java.
Pegasus volitans Linnaeus 1758	Longtail seamouth, (M, Br), Ref. 1418. Max. 17.5 cm TL. Known from Sumatera and Java.
Syngnathiformes (pipefishes and seahorses)	
Aulostomidae	**Trumpetfishes**
Aulostomus chinensis (Linnaeus 1766)	Chinese trumpetfish, (M), Ref. 8631. Max. 80 cm TL. Known from Flores.
Centriscidae	**Snipefishes and shrimpfishes**
Aeoliscus strigatus (Günther 1860)	Razorfish, (M), Ref. 8631. Max. 15 cm TL. Known from Flores.
Centriscus scutatus Linnaeus 1758	Grooved razorfish, (M, Br), Ref. 561. Max. 15 cm TL. Museum: NTM S.10749-007 (TGT1812). Found from southwest Sumatra to Timor Sea (Ref. 5978).
Fistulariidae	**Cornetfishes**
Fistularia commersonii Rüppell 1838	Bluespotted cornetfish, (M), Ref. 1602. Max. 160 cm TL.

Fistularia petimba Lacepède 1803	Red cc Mus Sum
Solenostomidae	**Ghost**
Solenostomus cyanopterus Bleeker 1854	Ghost Kno
Solenostomus paradoxus (Pallas 1770)	Harleq
Syngnathidae	**Pipefis**
Apterygocampus epinnulatus Weber 1913	(M), Re
Bhanotia fasciolata (Dumèril 1870)	(M), Re
Bulbonaricus brauni (Dawson & Allen 1978)	Pughe
Bulbonaricus davaoensis (Herald 1953)	(M), Re
Choeroichthys brachysoma (Bleeker 1855)	Short-b Fror
Choeroichthys cinctus Dawson 1976	(M), Re 214
Choeroichthys sculptus (Günther 1870)	Sculptu
Corythoichthys amplexus Dawson & Randall 1975	Brown- Fror
Corythoichthys flavofasciatus (Rnppell 1838)	Netwo from
Corythoichthys haematopterus (Bleeker 1851)	(M), R Flor
Corythoichthys intestinalis (Ramsay 1881)	Bande
Corythoichthys schultzi Herald 1953	Schult Also
Doryrhamphus dactyliophorus (Bleeker 1853)	Ringed Also
Doryrhamphus excisus excisus Kaup 1856	Bluest Ref.
Doryrhamphus janssi (Herald & Randall 1972)	Janss' Kno
Doryrhamphus multiannulatus (Regan 1903)	Many-
Doryrhamphus negrosensis negrosensis Herre 1934	(M),
Festucalex erythraeus (Gilbert 1905)	Red pi
Festucalex prolixus Dawson 1984	(M), R
Halicampus grayi Kaup 1856	Gray's
Halicampus macrorhynchus Bamber 1915	Ornate Fou reco
Haliichthys taeniophorus Gray 1859	Ribbo

Table 2. Continuation.
[Tabel 2. Sambungan.]

Hippichthys cyanospilos (Bleeker 1854)	Blue-spotted pipefish, (M, Br, Fr), Ref. 5316. Max. 16 cm SL. Nias, Java, and Banda (Ref. 7050).
Hippichthys penicillus (Cantor 1849)	Beady pipefish, (M, Br, Fr), Ref. 5316. Max. 18 cm SL. Kalimantan and Java (Ref. 7050).
Hippichthys spicifer (Rüppell 1838)	Bellybarred pipefish, (M, Br, Fr), Ref. 5316. Max. 17 cm SL. Sumatra, Java, and Sulawesi (Ref. 7050).
Hippocampus kuda Bleeker 1852	Spotted seahorse, (M, Br), Ref. 5978. Max. 30 cm TL. Also Ref.: 8631. Museum: NTM S.10749-006. Known from Bali Strait to Timor Sea, including Flores.
Ichthyocampus carce (Hamilton 1822)	(M, Br, Fr), Ref. 5316. Max. 14 cm SL. Sumatra, Kalimantan, Sulawesi, and Java (Ref. 7050).
Micrognathus brevirostris pygmaeus Fritzsche 1981	(M), Ref. 1602. Known from Moluccas.
Micrognathus micronotopterus (Fowler 1938)	(M), Ref. 5316. Max. 5.7 cm SL.
Microphis argulus (Peters 1855)	Flat-nosed pipefish, (M, Br, Fr), Ref. 5316. Max. 18 cm SL. Java and Flores (Ref. 7050).
Minyichthys brachyrhinus (Herald 1953)	(M), Ref. 5316. Max. 4.6 cm SL.
Minyichthys myersi (Herald & Randall 1972)	Myers' pipefish, (M), Ref. 1602. Max. 5.8 cm SL.
Phoxocampus belcheri (Kaup 1856)	Rock pipefish, (M), Ref. 5316. Max. 7.2 cm SL.
Phoxocampus tetrophthalmus (Bleeker 1858)	(M), Ref. 5316. Max. 7.5 cm SL.
Siokunichthys breviceps Smith 1963	(M), Ref. 5173. Max. 8 cm SL.
Siokunichthys herrei Herald 1953	(M), Ref. 5173. Max. 7.6 cm SL.
Siokunichthys nigrolineatus Dawson 1983	(M), Ref. 5173. Max. 7.4 cm SL. Also Ref.: 8631. Known from Flores.
Syngnathoides biaculeatus (Bloch 1785)	Alligator pipefish, (M), Ref. 8631. Max. 28.3 cm SL. Known from Bali.
Trachyrhamphus bicoarctatus (Bleeker 1857)	Double-ended pipefish, (M), Ref. 1602. Max. 39 cm SL.
Scorpaeniformes (scorpionfishes and flatheads)	
Aploactinidae	**Velvetfishes**
Erisphex philippinus (Fowler 1938)	(M), Ref. 5978. Museum: CAS 54604. From southwest Sumatra to Bali Strait.
Kanekonia aniara Thompson 1968	Darkfinned velvetfish, (M), Ref. 5978. Museum: CAS 54596. From Bali Strait to Timor Sea.
Kanekonia pelta Poss 1982	(M, En), Ref. 8937. Max. 2.85 cm SL. Halmahera Is. off Teluk Kau.
Bembridae	**Deepwater flatheads**
Bembradium roseum Gilbert 1905	(M), Ref. 5978. Max. 11 cm SL. Museum: NTM S.10760-004 (TGT1710). From Bali Strait to Timor Sea.
Bembras japonicus Cuvier 1829	(M), Ref. 5978. Max. 30 cm SL. Museum: USNM 264796 (TGT1726). From Bali Strait to Timor Sea.
Caracanthidae	**Orbicular velvetfishes**
Caracanthus maculatus (Gray 1831)	Spotted coral croucher, (M), Ref. 1602. Max. 5 cm.
Dactylopteridae	**Flying gurnards**
Dactyloptena macracanthus (Bleeker 1854)	Spotwing flying gurnard, (M), Ref. 3392. Max. 16.5 cm TL. Museum: CAS 53136 (TGT2464). From southwest Sumatra to Timor Sea (Ref. 5978).
Dactyloptena orientalis (Cuvier 1829)	Orie Al Fr in
Dactyloptena peterseni (Nyström 1887)	Starr M Se
Hoplichthyidae	**Gho**
Hoplichthys gilberti Jordan & Richardson 1908	(M), 26
Hoplichthys regani Jordan & Richardson 1908	Ghos Mi to
Platycephalidae	**Flatł**
Cociella crocodila (Tilesius 1812)	Croc Mı 19 In
Cociella punctatus (Cuvier 1829)	Spotl
Cymbacephalus beauforti (Knapp 1973)	Croc Mc
Cymbacephalus nematophthalmus (Günther 1860)	Fring
Elates ransonnetii (Steindachner 1876)	Dwar US to
Grammoplites scaber (Linnaeus 1758)	Roug Mu Str Ka
Inegocia japonica (Tilesius 1812)	Japar Mu Se
Levanaora bosschei (Bleeker 1860)	Smal
Onigocia macrolepis (Bleeker 1854)	Notch Mu Str
Onigocia pedimacula (Regan 1908)	(M), F
Onigocia spinosa (Temminck & Schlegel 1844)	(M), F
Platycephalus arenarius Ramsay & Ogilby 1886	North TL. Bal diff eas
Platycephalus indicus (Linnaeus 1758)	Indiar In r
Rogadius asper (Cuvier 1829)	Thorn Mu Str
Rogadius pristiger (Cuvier 1829)	(M), F

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Rogadius serratus (Cuvier 1829)	Serrated flathead, (M), Ref. 9790. Max. 24 cm TL.
Rogadius welanderi (Schultz 1966)	Welander's flathead, (M), Ref. 9790. Max. 13 cm TL. Museum: USNM 264803 (TGT3030). From Bali Strait to Timor Sea (Ref. 5978).
Sorsogona tuberculata (Cuvier 1829)	Tuberculated flathead, (M), Ref. 5978. Max. 14 cm TL. Museum: NTM S.11013-002 (TGT1799). From Bali Strait to Timor Sea. In range Ref.: 5999.
Suggrundus macracanthus (Bleeker 1869)	Large-spined flathead, (M), Ref. 5978. Max. 26 cm TL. Museum: CSIRO B.2126. From southwest Sumatra to Timor Sea.
Suggrundus rodericiensis (Cuvier 1829)	Spiny flathead, (M), Ref. 9790. Max. 25 cm.
Thysanophrys arenicola Schultz 1966	Broadhead flathead, (M), Ref. 9790. Max. 37 cm TL.
Thysanophrys carbunculus (Valenciennes 1833)	Papillose flathead, (M), Ref. 9790. Max. 18 cm TL.
Thysanophrys celebica (Bleeker 1854)	Celebes flathead, (M), Ref. 9790. Max. 15 cm TL. Celebes and Irian Barat.
Thysanophrys chiltonae Schultz 1966	Longsnout flathead, (M), Ref. 2334. Max. 23 cm TL.
Thysanophrys malayanus (Bleeker 1853)	(M), Ref. 5978. Museum: NTM S.10734-015 (TGT1221). From southwest Sumatra to Timor Sea.
Thysanophrys otaitensis (Parkinson 1829)	Fringelip flathead, (M), Ref. 9790. Max. 25 cm TL.
Scorpaenidae	**Scorpionfishes or rockfishes**
Ablabys taenianotus (Cuvier 1829)	Cockatoo waspfish, (M, Dan), Ref. 3132. Max. 10 cm TL.
Apistus carinatus (Bloch & Schneider 1801)	Ocellated waspfish, (M, Fi, Dan), Ref. 5978. Max. 18 cm. Museum: LPPL JIF19 (TGT1198). From southwest Sumatra to Darwin.
Cottapistus cottoides (Linnaeus 1764)	Marbled stingfish, (M), Ref. 5978. Museum: UMMZ 212292 (TGT3245). From Bali Strait to Timor Sea.
Dendrochirus biocellatus (Fowler 1938)	Twospot turkeyfish, (M, Dan), Ref. 8631. Max. 10 cm. Known from Flores.
Dendrochirus brachypterus (Cuvier 1829)	Shortfin turkeyfish, (M, Dan), Ref. 5978. Max. 17 cm. Also Ref.: 8631. Known from Bali Strait to Timor Sea, including Flores.
Dendrochirus zebra (Cuvier 1829)	Zebra turkeyfish, (M, Dan), Ref. 5978. Max. 25 cm SL. Also Ref.: 8631. Museum: CSIRO CA1303.From Bali Strait to Timor Sea.
Ebosia bleekeri (Döderlein 1884)	(M), Ref. 5978. Museum: ANSP 152033 (TGT3189). From Bali Strait to Timor Sea.
Ectreposebastes imus Garman 1899	(M, Fi), Ref. 5978. Max. 18 cm SL. Museum: BMNH 1984. 1.1.63 (TGT (PJPW) 824). From southwest Sumatra to Bali Strait.
Inimicus cuvieri (Gray 1835)	(M), Ref. 5978. Museum: LPPL JIF20 (TGT1394). From Bali Strait to Timor Sea.
Inimicus didactylus (Pallas 1769)	Bearded ghoul, (M, Br, Dan), Ref. 5978. Max. 21.5 cm TL. Museum: LPPL JIF (TGT2366). From southwest Sumatra to Bali Strait.
Inimicus sinensis (Valenciennes 1833)	Spotted ghoul, (M, Dan), Ref. 5978. Max. 26 cm. Museum: BMNH 1984.1.1.64 (TGT (PJPW) 711). From southwest Sumatra to Bali Strait.

Lioscorpius longiceps Günther 1880	(M, Dar
Minous monodactylus (Bloch & Schneider 1801)	Grey st
Minous pictus Günther 1880	Painted 002 (
Neocentropogon aeglefinis (Weber 1913)	(M), Re From
Neomerinthe amplisquamiceps (Fowler 1938)	(M), Re
Neomerinthe megalepis (Fowler 1938)	(M), Re From
Neomerinthe procurva Chen 1981	(M), Re From
Neomerinthe rotunda Chen 1981	(M), Re From
Paracentropogon longispinus (Cuvier 1829)	Wispy 1531
Pontinus macrocephalus (Sauvage 1882)	(M), Re From
Pteroidichthys amboinensis Bleeker 1856	(M), Re and
Pterois antennata (Bloch 1787)	Broadb TL. (TG inclu
Pterois mombasae (Smith 1957)	Frillfin Mus Sea.
Pterois radiata Cuvier 1829	Radial Mus Timo
Pterois russelli Bennett 1831	Plainta
Pterois volitans (Linnaeus 1758)	Lionfisl Mus Timo
Rhinopias frondosa (Günther 1891)	Weedy Mus to Ti
Scorpaena picta (Cuvier 1829)	Northe Mus
Scorpaenodes albaiensis (Evermann & Seale 1907)	Longfir Max
Scorpaenodes guamensis (Quoy & Gaimard 1824)	Guam Kno
Scorpaenopsis cirrhosa (Thunberg 1793)	Weedy Kno
Scorpaenopsis diabolus Cuvier 1829	False
Scorpaenopsis macrochir Ogilby 1910	Flashe
Scorpaenopsis neglecta Heckel 1837	(M, Da
Scorpaenopsis oxycephalus	Tassle

Table 2. Continuation.
[Tabel 2. Sambungan.]

(Bleeker 1849)	Museum: NTM S.10734-014 (TGT1227). From southwest Sumatra to Timor Sea.
Scorpaenopsis venosa (Cuvier 1829)	Raggy scorpionfish, (M, Dan), Ref. 2334. Max. 18 cm TL.
Sebastapistes cyanostigma (Bleeker 1856)	Yellowspotted scorpionfish, (M, Dan), Ref. 8631. Max. 8 cm. Known from Bali.
Sebastiscus tertius (Basukov & Chen 1978)	(M), Ref. 5978. Max. 37 cm SL. Museum: SDSU 83-14 (TGT1751). From Bali Strait to 0Timor Sea.
Setarches guentheri Johnson 1862	Channeled rockfish, (M, Fi, Dan), Ref. 3503. Max. 24 cm.
Setarches longimanus (Alcock 1894)	(M, Dan), Ref. 5978. Max. 18 cm SL. Museum: CSIRO CA1584. From southwest Sumatra to Bali Strait. In range Ref.: 559.
Snyderina yamanokami Jordan & Starks 1901	(M), Ref. 5978. Max. 24 cm TL. Museum: UMMZ 212291 (TGT3192). From Bali Strait to Timor Sea.
Synanceia verrucosa Bloch & Schneider 1801	Stonefish, (M, Dan), Ref. 5978. Max. 40 cm SL. Museum: LPPL JIF18 (TGT1020). From Bali Strait to Timor Sea.
Tetraroge barbata (Cuvier 1829)	Bearded roguefish, (M, Br, Fr, Dan), Ref. 7050. Max. 10 cm TL. Known in Sumatra, Java, Sulawesi, Seram, and Irian Jaya.
Tetraroge niger (Cuvier 1829)	(M, Br, Fr, Dan), Ref. 7050. Max. 13.5 cm TL. Known in Sumatra, Bali, Sulawesi and Moluccas.
Vespicula depressifrons (Richardson 1848)	(M, Br, Fr, Dan), Ref. 7050. Max. 10 cm TL. Sumatra, Bali, Sulawesi, Moluccas, and Irian Jaya.
Triglidae	**Searobins**
Gargariscus prionocephalus (Duméril 1869)	(M), Ref. 559. Max. 30 cm TL.
Lepidotrigla japonica (Bleeker 1857)	(M), Ref. 5978. Max. 20 cm TL. Museum: NTM S.11013-004 (TGT1797). From Bali Strait to Timor Sea. Also Ref.: 559.
Lepidotrigla punctipectoralis Fowler 1938	(M), Ref. 5978. Max. 20 cm TL. Museum: NTM S.10752-015 (TGT3198). From southwest Sumatra to Timor Sea.
Lepidotrigla spiloptera Günther 1880	Spotwing gurnard, (M), Ref. 5978. Max. 10 cm. Museum: NTM S.10999-004 (TGT2460). From southwest Sumatra to Timor Sea. In range Ref.: 3542.
Paraheminodus murrayi (Günther 1880)	(M), Ref. 9771
Peristedion liorhynchus Günther 1872	Armoured gurnard, (M), Ref. 5978. Max. 40 cm. Museum: AMS I.22807-028. From Bali Strait to Timor Sea.
Pterygotrigla hemisticta (Temminck & Schlegel 1842)	Blackspotted gurnard, (M), Ref. 5978. Max. 25 cm. Museum: NTM S.10760-016 (TGT1737). From southwest Sumatra to Timor Sea.
Pterygotrigla leptacanthus (Günther 1880)	Black-finned gurnard, (M), Ref. 3132. Max. 15 cm TL.
Pterygotrigla multiocellata (Matsubara 1937)	(M), Ref. 9771.
Pterygotrigla ryukyuensis Matsubara & Hiyama 1932	(M), Ref. 5978. Max. 30 cm TL. Museum: NTM S.10998-007 (TGT2525). From southwest Sumatra to Timor Sea. Also Ref.: 559.
Satyrichthys adeni (Lloyd 1907)	(M), Ref. 5978. Max. 70 cm TL. Museum: NTM S.10760-017 (TGT1740). From Bali Strait to Timor Sea. A new

	re
Satyrichthys moluccense (Bleeker 1850)	Blac M sc
Satyrichthys rieffeli (Kaup 1859)	Spot M sc
Perciformes (perch-likes)	
Acanthoclinidae	**Spin**
Acanthoplesiops hiatti Schultz 1953	(M),
Acanthuridae	**Surg**
Acanthurus auranticavus Randall 1956	Oran cm
Acanthurus bariene (Lesson 1830)	Black Als Str
Acanthurus blochii Valenciennes 1835	Ringt
Acanthurus dussumieri Valenciennes 1835	Eyest Frc
Acanthurus fowleri De Beaufort 1951	Fowle Flc
Acanthurus grammoptilus Richardson 1843	Fineli
Acanthurus japonicus Schmidt 1930	(M), F
Acanthurus leucocheilus Herre 1927	Paleli Kn
Acanthurus leucosternon Bennett 1832	Powd cm
Acanthurus lineatus (Linnaeus 1758)	Lined TL. (PA
Acanthurus maculiceps (Ahl 1923)	White Ma:
Acanthurus mata Cuvier 1829	Blue-li cm Stra
Acanthurus nigricans (Linnaeus 1758)	White TL.
Acanthurus nigricauda *Duncker & Mohr 1929*	Epaule cm (Re
Acanthurus nigrofuscus (Forsskäl 1775)	Brown Knc 192
Acanthurus nubilus (Fowler & Bean 1929)	Bluelir Ref. Gul
Acanthurus olivaceus Bloch & Schneider 1801	Orang Max Fror
Acanthurus pyroferus	Choco

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Kittlitz 1834	TL. Known from Bali and Flores.
Acanthurus thompsoni (Fowler 1923)	Thompson's surgeonfish, (M), Ref. 8631. Max. 27 cm TL. Known from Flores. Also from Java and Sumatra (Ref. 1920).
Acanthurus triostegus (Linnaeus 1758)	Convict surgeonfish, (M, Fi, Dan), Ref. 8631. Max. 27 cm TL. Known from Bali. Also from Java and Sumatra (Ref. 1920).
Acanthurus tristis Randall 1993	Indian Ocean mimic surgeonfish, (M), Ref. 8940. Max. 16.5 cm SL. Also Ref.: 8631.
Acanthurus xanthopterus Valenciennes 1835	Yellowfin surgeonfish, (M, Fi, Dan), Ref. 5978. Max. 70 cm. Also Ref.: 8631. Museum: LPPL JIF210 (TGT1034). From southwest Sumatra to Timor Sea.
Ctenochaetus binotatus Randall 1955	Twospot surgeonfish, (M, Dan), Ref. 1602. Max. 22 cm TL.
Ctenochaetus striatus (Quoy & Gaimard 1825)	Striated surgeonfish, (M, Dan), Ref. 8631. Max. 26 cm TL. Known from Bali.
Ctenochaetus strigosus (Bennett 1828)	Spotted surgeonfish, (M), Ref. 1602. Max. 13.9 cm SL.
Ctenochaetus tominiensis Randall 1955	Tomini surgeonfish, (M), Ref. 1602. Max. 10 cm SL. Also Ref.: 8631. Known from Bali and Sulawesi (Celebes).
Naso annulatus (Quoy & Gaimard 1825)	White margin unicornfish, (M), Ref. 1602. Max. 100 cm TL.
Naso brachycentron (Valenciennes 1835)	Humpback unicornfish, (M), Ref. 5978. Max. 90 cm FL. Museum: LPPL JIF130 (TGT3175). From southwest Sumatra to Timor Sea.
Naso brevirostris (Valenciennes 1835)	Spotted unicornfish, (M), Ref. 1602. Max. 60 cm FL.
Naso fageni Morrow 1954	Horseface unicornfish, (M), Ref. 8631. Max. 80 cm. Known from Flores.
Naso hexacanthus (Bleeker 1855)	Sleek unicornfish, (M, Fi, Sport), Ref. 8631. Max. 75 cm FL. Known from Flores.
Naso lituratus (Bloch & Schneider 1801)	Orangespine unicornfish, (M, Dan), Ref. 5978. Max. 45 cm TL. From southwest Sumatra to Timor. Sea. Also Ref.: 8631.
Naso lopezi Herre 1927	Elongate unicornfish, (M), Ref. 1602. Max. 54 cm FL. Also Ref.: 8631. From southwest Sumatra to Bali Strait (Ref. 5978).
Naso minor (Smith 1966)	Slender unicorn, (M), Ref. 4974. Max. 20 cm TL.
Naso thynnoides (Valenciennes 1835)	Oneknife unicornfish, (M), Ref. 5978. Max. 40 cm. From southwest Sumatra to Timor Sea. Also Ref.: 8631.
Naso tuberosus Lacepède 1801	Humpnose unicornfish, (M), Ref. 5978. Max. 60 cm FL. Museum: LPPI JIF133 (TGT2343). From southwest Sumatra to Timor Sea.
Naso unicornis (Forsskål 1775)	Bluespine unicornfish, (M, Sport, Dan), Ref. 5978. Max. 70 cm TL. Also Ref.: 8631. From southwest Sumatra to Timor Sea.
Naso vlamingii (Valenciennes 1835)	Bignose unicornfish, (M), Ref. 8631. Max. 55 cm TL. Known from Bali.
Zebrasoma scopas (Cuvier 1829)	Twotone tang, (M), Ref. 1602. Max. 20 cm SL.
Zebrasoma veliferum (Bloch 1795)	Sailfin tang, (M), Ref. 1602. Max. 40 cm TL.

Acropomatidae	**Lanter**
Acropoma japonicum Günther 1859	Glow-b JIF4 Sea.
Doederleinia berycoides (Hilgendorf 1879)	(M), Re (con Timc
Malakichthys elegans Matsubara & Yamaguti 1943	(M), Re 019 Strai
Synagrops japonicus (Döderlein 1883)	Japane Mus Sum
Synagrops philippinensis (Günther 1880)	(M), Re Fron
Ambassidae	**Glass**
Ambassis gymnocephalus (Lacepéde 1802)	Bald gl TL.
Ambassis urotaenia Bleeker 1852	(M, Br,
Ammodytidae	**Sand I**
Bleekeria mitsukurii Jordan & Evermann 1902	(M), Re 007
Bleekeria viridianguilla (Fowler 1931)	(M), Re Fror
Apogonidae	**Cardin**
Apogon angustatus (Smith & Radcliffe 1911)	Striped Kno
Apogon apogonides (Bleeker 1856)	Shorttc Ref. P.28 Sum
Apogon aureus (Lacepède 1802)	Ringtai Also (TG 597
Apogon bandanensis Bleeker 1854	Bigeye
Apogon brevicaudata Weber 1909	Manyb WAI
Apogon ceramensis Bleeker 1852	Ceram Mus Stra
Apogon chrysotaenia Bleeker 1851	Many-l Mar Flor
Apogon coccineus Rüppell 1838	Ruby c Kno Mau com
Apogon compressus (Smith & Radcliffe 1911)	Ochre- 863
Apogon cookii Macleay 1881	Cook's Kno
Apogon cyanosoma	Yellow

Table 2. Continuation.
[Tabel 2. Sambungan.]

Bleeker 1853	the Manado area, Sulawesi (Celebes).
Apogon dispar Fraser & Randall 1976	Redspot cardinalfish, (M), Ref. 8631. Max. 4.8 cm SL. Known from Flores.
Apogon ellioti Day 1875	Flag-in cardinalfish, (M), Ref. 5978. Max. 16 cm TL. Museum: NTM S.10996-003 (TGT2308). From southwest Sumatra to Timor Sea. In range Ref.: 1602.
Apogon evermanni Jordan & Snyder 1904	Evermann's cardinalfish, (M), Ref. 8631. Max. 11 cm SL. Known from Flores.
Apogon exostigma (Jordan & Starks 1906)	Narrowstripe cardinalfish, (M), Ref. 8631. Max. 9.4 cm SL. Known from Flores.
Apogon fasciatus	Broadbanded cardinalfish, Glaga, (M), Ref. 5978. Max. 13 cm TL. White 1790 Museum: LPPL JIF41 (TGT2160). From southwest Sumatra to Timor Sea. In range Ref.: 4329.
Apogon fleurieu (Lacepède 1802)	Cardinalfish, (M), Ref. 2142. Max. 11 cm SL. Museum: BMNH 1855.3.24.41, Ambon.
Apogon fraenatus Valenciennes 1832	Bridled cardinalfish, (M), Ref. 8631. Max. 8.5 cm SL. Known from Bali.
Apogon fragilis Smith 1961	Fragile cardinalfish, (M), Ref. 1602. Max. 4.3 cm SL. Known from Maumere Bay, Flores (Allen, pers. comm.).
Apogon fuscus Quoy & Gaimard 1825	Samoan cardinalfish, (M), Ref. 8631. Max. 7.7 cm SL. Known from Flores.
Apogon gilberti (Jordan & Seale 1905)	Gilbert's cardinalfish, (M), Ref. 1602. Max. 4.2 cm SL.
Apogon guamensis Valenciennes 1832	Guam cardinalfish, (M), Ref. 8631. Max. 7.9 cm SL. Known from Bali.
Apogon hartzfeldii Bleeker 1852	Hartzfeld's cardinalfish, (M), Ref. 8631. Max. 8.2 cm SL. Known from Bali, Flores, and the Moluccas. Also Ref.: 1602.
Apogon hoevenii Bleeker 1854	Frostfin cardinalfish, (M), Ref. 5978. Max. 5 cm TL. Also Ref.: 8631. Museum: WAM P.28046-001 (TGT1051). From Bali Strait to Timor Sea.
Apogon kallopterus Bleeker 1856	Iridescent cardinalfish, (M), Ref. 8631. Max. 12.2 cm SL. Known from Bali.
Apogon kiensis Jordan & Snyder 1901	Rifle cardinal, (M, Br), Ref. 8631. Max. 8 cm TL. Known from Flores.
Apogon lateralis Valenciennes 1832	Humpback cardinal, (M, Br, Fr), Ref. 7050. Max. 8 cm SL. Also Ref.: 8631. Known from Flores.
Apogon leptacanthus Bleeker 1856	Threadfin cardinalfish, (M), Ref. 1602. Max. 4.5 cm SL. Known from Maumere Bay, Flores and Komodo I., Allen, pers. comm.
Apogon melas Bleeker 1848	Black cardinalfish, (M), Ref. 1602. Max. 9.2 cm SL.
Apogon moluccensis Valenciennes 1832	Moluccan cardinalfish, (M), Ref. 5978. Max. 9 cm TL. Also Ref.: 8631. Museum: WAM P.28044-004 (TGT1049). From Bali Strait to Timor Sea.
Apogon multilineatus (Bleeker 1865)	Many-lined cardinalfish, Multi-striped cardinal, (M), Ref. 8631. Max. 10 cm TL. From Flores. In range Ref.: 6192.
Apogon nigripinnis Cuvier 1828	Bullseye, (M), Ref. 5978. Max. 10 cm TL. Museum: CSIRO CA1617. From Bali Strait to Timor Sea. In range Ref.: 4329.

Apogon nigrocincta (Smith & Radcliffe 1912)	(M), I Fr
Apogon nigrofasciatus Lachner 1953	Black Als
Apogon notatus (Houttuyn 1782)	Spotr Kn
Apogon novemfasciatus Cuvier 1828	Seve SL (T
Apogon perlitus Fraser & Lachner 1985	Pearl Kn Ko
Apogon poecilopterus Cuvier 1828	Pearl Ma Tir
Apogon sangiensis Bleeker 1857	Sang
Apogon sealei Fowler 1918	Seale Kn
Apogon semilineatus Temminck & Schlegel 1842	Half-l TL Fro
Apogon semiornatus Peters 1876	Obliq TL (Al
Apogon septemstriatus Günther 1880	(M), I Fro
Apogon taeniophorus Regan 1908	Reef- 16 Su Ko
Apogon thermalis Cuvier 1829	Half-l Ba
Apogon timorensis Bleeker 1854	Timo cm Ba
Apogon trimaculatus Cuvier 1828	Three SL
Archamia biguttata Lachner 1951	Twins Al
Archamia dispilus Lachner 1951	(M), I
Archamia fucata (Cantor 1849)	Oran SL (T inc
Archamia lineolata (Ehrenberg 1828)	Shim Kn
Archamia zosterophora (Bleeker 1858)	Black Als
Cheilodipterus alleni Gon 1993	(M), I Flo
Cheilodipterus artus Smith 1961	Wolf Als Ce

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

	Ambon, BPBM 31471; ZMH 14372.Bone Rate Is., BPBM 31512. Also known from Flores.
Cheilodipterus isostigmus (Schultz 1940)	Dog-toothed cardinalfish, (M), Ref. 1602. Max. 9.3 cm SL. Museum: NTM S.10733-019 (TGT1064). From Bali Strait to Timor Sea (Ref. 5978).
Cheilodipterus macrodon (Lacepède 1802)	Largetoothed cardinalfish, (M), Ref. 5978. Max. 20 cm SL. Also Ref.: 8525. Museum: LPPL JIF42 (TGT1589). From Bali Strait to Timor Sea. Bay of Jakarta, ZMA 101.377. Lombok, BPBM 30048. Sulawesi, Ujung Pandang (Makassar), RMNH 74.
Cheilodipterus nigrotaeniatus Smith & Radcliffe 1912	(M), Ref. 8525. Max. 6.4 cm SL. Museum: Molucca Is., Halmahera I., USNM 112305.
Cheilodipterus quinquelineatus Cuvier 1828	Fivelined cardinalfish, (M), Ref. 8631. Max. 13 cm TL. Known from Flores.
Cheilodipterus singapurensis Bleeker 1859	Truncate cardinalfish, (M), Ref. 8525. Max. 17.5 cm SL. Museum: Java, USNM 261570. Krimundjawa I., USNM 261573. Celebes, (Makassar), USNM 149337; ZMA 101.379 (Holotypeof *C. subulatus* Weber). Kabaena I., USNM 261567. Buru I., USNM 149335. Doworra I., USNM 149336. Misol I., BMNH 1870.8.31.15.
Foa brachygramma (Jenkins 1903)	Weed cardinalfish, (M), Ref. 1602. Max. 4 cm SL. Known from Maumere Bay, Flores, Allen pers. comm.
Fowleria abocellata Goren & Karplus 1980	(M), Ref. 2334. Max. 5 cm TL.
Fowleria aurita (Valenciennes 1831)	Crosseyed cardinalfish, (M), Ref. 2334. Max. 9 cm TL.
Fowleria marmorata (Alleyne & MacLeay 1877)	Marbled cardinalfish, (M), Ref. 1602. Max. 7.5 cm TL. Known from the Manado area, Sulawesi (Celebes) and Maumere Bay, Flores, Allen pers. comm.
Fowleria variegata (Valenciennes 1832)	Variegated cardinalfish, (M), Ref. 1602. Max. 6.5 cm SL. Known from Komodo I. (Allen, pers. comm.).
Gymnapogon urospilotus Lachner 1953	(M), Ref. 1602. Max. 2.7 cm SL. Known from Maumere Bay, Flores (Allen pers. comm.).
Pseudamia amblyuroptera (Bleeker 1856)	(M, Br), Ref. 526. Max. 8 cm SL. Museum: NTM S.10824-001 (TGT2370). Found from Bali Strait to Timor Sea (Ref. 5978).
Pseudamia gelatinosa Smith 1955	Gelatinous cardinalfish, (M), Ref. 526. Max. 7.9 cm SL.
Pseudamia hayashii Randall, Lachner & Fraser 1985	Hayashi's cardinalfish, (M), Ref. 526. Max. 6.2 cm SL.
Pterapogon kauderni Koumans 1933	(M), Ref. 9936. Apparently restricted to the Benggai Is. off the east coast of central Sulawesi (Celebes), Indonesia. Museum: RMNH 17003.
Rhabdamia cypselurus Weber 1909	(M), Ref. 1602. Max. 5.1 cm SL. Known from the Manado area, Sulawesi (Celebes), Maumere Bay, Flores, and Komodo I. (Allen, pers. comm.).
Rhabdamia gracilis (Bleeker 1856)	Luminous cardinalfish, (M), Ref. 8631. Max. 5.1 cm SL. In range Ref.: 1602. Museum: WAM P.28137-00 (TGT2283). Found from southwest Sumatra to Timor Sea (Ref. 5978); including Flores.
Siphamia fistulosa (Weber 1909)	(M), Ref. 1602. Max. 1.6 cm SL.
Siphamia fuscolineata	Crown-of-thorns cardinalfish, (M), Ref. 5978. Max. 4 cm
Lachner 1953	SL Ba
Siphamia majimae Matsubara & Iwai 1958	(M), I co
Siphamia versicolor (Smith & Radcliffe 1911)	(M), I Mu Str
Sphaeramia nematoptera (Bleeker 1856)	Pajar Als
Sphaeramia orbicularis (Cuvier 1828)	Orbic Als Kn
Ariommatidae	**Arior**
Ariomma brevimanum (Klunzinger 1884)	(M), F 10 Tin
Ariomma indica (Day 1870)	Indiar Mu sou
Banjosidae	
Banjos banjos (Richardson 1846)	(M), F P.1
Blenniidae	**Coml**
Andamia tetradactylus (Bleeker 1858)	(M), F Kn
Aspidontus dussumieri (Valenciennes 1836)	Lance Kn
Aspidontus taeniatus taeniatus Quoy & Gaimard 1834	False
Atrosalarias fuscus holomelas (Günther 1872)	Browr Kn
Blenniella bilitonensis (Bleeker 1858)	(M), F
Blenniella periophthalmus (Valenciennes 1836)	Blue-c SL.
Cirripectes auritus Carlson 1981	Blackt Kn
Cirripectes castaneus (Valenciennes 1836)	Chest Als
Cirripectes filamentosus (Alleyne & Macleay 1877)	Filame
Cirripectes gilberti Williams 1988	(M), F off /
Cirripectes polyzona (Bleeker 1868)	Barrec
Cirripectes quagga (Fowler & Ball 1924)	Squig
Cirripectes springeri Williams 1988	Spring Ref
Cirripectes stigmaticus Strasburg & Schultz 1953	Red-s
Crossosalarias macrospilus Smith-Vaniz & Springer 1971	Tripple
Ecsenius bandanus Springer 1971	Banda Mus

	Banda Sea). Seribu Is., USNM 211988. Karimundjawa, USNM 211979. Bone Betang, BPBM 26720. Kabaena, AMS I.18490-001. Ambon, USNM 209767. Ceram, USNM 209660. Saparua, USNM 209991. Biak, USNM 221236.
Ecsenius bathi Springer 1988	Bath's comb-tooth, (M, En), Ref. 5296. Max. 3.6 cm SL. Known from Bali, Toko Toko Rock. Also from Flores (Ref. 8631).
Ecsenius bicolor (Day 1888)	Bicolor blenny, (M), Ref. 5296. Max. 11 cm TL. Also Ref.: 8631. Known from Bali.
Ecsenius lividanalis Chapman & Schultz 1952	(M), Ref. 5296. Max. 4 cm TL.
Ecsenius melarchus McKinney & Springer 1976	Yellow-eyed comb-tooth, (M), Ref. 5296. Max. 5 cm TL. Also Ref.: 8631. Known from Flores.
Ecsenius midas Starck 1969	Persian blenny, (M), Ref. 5296. Max. 13 cm TL. Also Ref.: 8631. Known from Flores.
Ecsenius monoculus Springer 1988	(M), Ref. 5296. Max. 5 cm TL.
Ecsenius namiyei (Jordan & Evermann 1903)	Black comb-tooth, (M), Ref. 5296. Max. 9 cm TL. Also Ref.: 8631. Known from Bali.
Ecsenius paroculus Springer 1988	(M), Ref. 5296 Museum: Pulau Tikus, Pulau Pari Group, Pulau Seribu, USNM 260389 (Holotype). Also known from Bawean I. off N central Java.
Ecsenius pictus McKinney & Springer 1976	White-lined comb-tooth, (M), Ref. 5296. Max. 5 cm TL. Also Ref.: 8631. Known from Moluccas, Bone Rate islands, and Flores.
Ecsenius schroederi McKinney & Springer 1976	(M), Ref. 9137. Max. 7 cm TL.
Ecsenius stigmatura Fowler 1952	(M), Ref. 5296. Max. 6 cm TL.
Ecsenius trilineatus Springer 1972	Three-lined blenny, White-spotted comb-tooth, (M), Ref. 5296. Max. 2.7 cm SL. Museum: Moluccas, Saparua, USNM 211926; Banda Islands, USNM 211930, 211941, 211945; presumably Banda Sea, USNM 202477. Kai Islands, USNM 221239. Also from Flores (Ref. 8631).
Ecsenius yaeyamaensis (Aoyagi 1954)	Yaeyama blenny, (M), Ref. 5296. Max. 5.2 cm SL. Also Ref.: 8631. Known from Flores.
Enchelyurus kraussi (Klunzinger 1871)	Krauss' blenny, (M), Ref. 1602. Max. 4.5 cm SL.
Entomacrodus caudofasciatus (Regan 1909)	Tail-barred rockskipper, (M), Ref. 1602. Max. 6.2 cm SL.
Entomacrodus decussatus (Bleeker 1857)	Wavy-lined blenny, (M), Ref. 1602. Max. 6.7 cm SL.
Entomacrodus thalassinus (Jordan & Seale 1906)	(M), Ref. 1602. Max. 4 cm SL.
Exallias brevis (Kner 1868)	Leopard blenny, (M), Ref. 8631. Max. 11 cm SL. Known from Flores.
Istiblennius chrysospilos (Bleeker 1857)	Redspotted blenny, (M), Ref. 1602. Max. 11 cm SL.
Istiblennius cyanostigma (Bleeker 1849)	Bluespotted blenny, (M), Ref. 1602. Max. 7.4 cm SL. Known from Moluccas.
Istiblennius dussumieri (Valenciennes 1836)	Streaky rockskipper, (M, Br), Ref. 2334. Max. 12 cm.
Istiblennius edentulus (Schneider & Forster 1801)	Rippled rockskipper, (M, Fr), Ref. 1602. Max. 14 cm SL.
Istiblennius lineatus (Valenciennes 1836)	Line
Laiphognathus multimaculatus Smith 1955	Spot
Litobranchus fowleri (Herre 1926)	Fowl
Meiacanthus anema (Bleeker 1852)	(M, E Su
Meiacanthus atrodorsalis (Günther 1877)	Fork Al
Meiacanthus ditrema Smith-Vaniz 1976	Ones Ma ar
Meiacanthus grammistes (Valenciennes 1836)	Strip Ma Fl
Meiacanthus smithi Klausewitz 1961	Disc W
Meiacanthus vittatus Smith-Vaniz 1976	(M),
Nannosalarias nativitatus (Regan 1909)	Pygn
Omobranchus elongatus (Peters 1855)	Clois
Omobranchus punctatus (Valenciennes 1836)	Muzz
Omox biporos Springer 1972	Omo
Petroscirtes breviceps (Valenciennes 1836)	Stripe Ma
Petroscirtes mitratus Rüppell 1830	Flora Kn
Petroscirtes thepassii (Bleeker 1853)	Thep Ma
Petroscirtes variabilis Cantor 1850	Varia Ma
Petroscirtes xestus Jordan & Seale 1906	Xestu SL
Plagiotremus laudandus (Whitley 1961)	Bicol Kn
Plagiotremus rhinorhynchos (Bleeker 1852)	Blues
Plagiotremus tapeinosoma (Bleeker 1857)	Pianc SL
Praealticus amboinensis (Bleeker 1857)	Ambo Kn
Salarias ceramensis Bleeker 1852	(M), F
Salarias fasciatus (Bloch 1786)	Jewe Kn
Salarias guttatus Valenciennes 1836	Breas Flo
Salarias sinuosus Snyder 1908	Fring

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[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Stanulus seychellensis Smith 1959	Seychelle's blenny, (M), Ref. 1602. Max. 2.7 cm SL.
Xiphasia matsubarai Okada & Suzuki 1952	Japanese snake blenny, (M), Ref. 1602. Max. 30 cm SL.
Xiphasia setifer Swainson 1839	Hairtail blenny, (M), Ref. 2334. Max. 53 cm. Also Ref.: 8631. Museum: CSIRO CA2282, from southwest Sumatra to Bali Strait (Ref. 5978).
Bramidae	**Pomfrets**
Brama dussumieri Cuvier 1831	Lowfin pomfret, (M), Ref. 5978. Max. 19 cm SL. Museu Museum: NTM S.11119-001. From southwest Sumatra to Bali Strait. In range Ref.: 3326.
Taractes rubescens (Jordan & Evermann 1887)	Black pomfret, (M), Ref. 5978. Max. 70 cm SL. Museum: LPPL JIF50 (TGT2125). From Bali Strait to Timor Sea.
Caesionidae	**Fusiliers**
Caesio caerulaurea Lacepède 1801	Blue and gold fusilier, Pisang-pisang, (M, Fi, Bait), Ref. 402. Max. 35 cm TL.
Caesio cuning (Bloch 1791)	Redbelly yellowtail fusilier, Ekor kuning, (M, Fi), Ref. 402. Max. 60 cm TL. Museum: BPBM 29378 (TGT2172). From southwest Sumatra to Timor Sea (Ref. 5978).
Caesio lunaris Cuvier 1830	Lunar fusilier, Pisang-pisang, (M, Fi), Ref. 402. Max. 40 cm TL. Museum: BPBM 29334, from Bali Strait to Timor Sea (Ref. 5978).
Caesio teres Seale 1906	Yellow and blueback fusilier, Ekor kuning pisang, (M, Fi), Ref. 402. Max. 40 cm TL. Museum: BPBM 29367, from Bali Strait to Timor Sea (Ref. 5978).
Caesio varilineata Carpenter 1987	Variable-lined fusilier, (M, Fi, Bait), Ref. 402. Max. 40 cm TL.
Caesio xanthonota Bleeker 1853	Yellowback fusilier, Ekor kuning pisang, (M, Fi), Ref. 402. Max. 40 cm TL. Museum: BPBM 29375, from southwest Sumatra to Timor Sea (Ref. 5978).
Dipterygonotus balteatus (Valenciennes 1830)	Mottled fusilier, (M, Fi, Bait), Ref. 402. Max. 14 cm TL. Museum: BPBM 29376, from southwest Sumatra to Timor Sea (Ref. 5978).
Gymnocaesio gymnoptera (Bleeker 1856)	Slender fusilier, (M, Fi, Bait), Ref. 402. Max. 18 cm TL. Museum: BPBM 29377, from southwest Sumatra to Timor Sea (Ref. 5978).
Pterocaesio chrysozona (Cuvier 1830)	Goldband fusilier, Pisang-pisang, (M, Fi, Bait), Ref. 402. Max. 21 cm TL. Museum: WAM P.26191-003. From southwest Sumatra to Bali Strait (Ref. 5978).
Pterocaesio digramma (Bleeker 1865)	Double-lined fusilier, (M, Fi), Ref. 402. Max. 30 cm TL. Museum: BPBM 29341, from Bali Strait to Timor Sea (Ref. 5978).
Pterocaesio marri Schultz 1953	Marr's fusilier, (M, Fi, Bait), Ref. 402. Max. 35 cm TL.
Pterocaesio pisang (Bleeker 1853)	Banana fusilier, Pisang-pisang, (M, Fi, Bait), Ref. 402. Max. 21 cm TL. Museum: BPBM 29342, from southwest Sumatra to Timor Sea (Ref. 5978).
Pterocaesio randalli Carpenter 1987	Randall's fusilier, (M, Fi), Ref. 402. Max. 25 cm TL.
Pterocaesio tessellata Carpenter 1987	One-stripe fusilier, (M, Fi), Ref. 402. Max. 25 cm TL. Museum: BPBM 29368 (TGT1582). From southwest Sumatra to Timor (Ref. 5978).
Pterocaesio tile (Cuvier 1830)	Dark-banded fusilier, (M, Fi, Bait), Ref. 402. Max. 30 cm TL.
Pterocaesio trilineata Carpenter 1987	Three TL.
Callionymidae	**Drago**
Anaora tentaculata Gray 1835	(M), F
Callionymus filamentosus Valenciennes 1837	Blotch Mu sou
Callionymus japonicus Houttuyn 1782	(M), F Fro
Callionymus meridionalis Suwardji 1965	(M), F (TG
Callionymus semeiophor Fricke 1983	(M), F Fro
Callionymus superbus Fricke 1983	(M), F Fro
Callionymus whiteheadi Fricke 1981	(M), F (Su Sur
Diplogrammus goramensis (Bleeker 1858)	(M), F
Synchiropus altivelis (Temminck & Schlegel 1850)	(M), F 011
Synchiropus morrisoni Schultz 1960	Morris In
Synchiropus ocellatus (Pallas 1770)	Ocella
Synchiropus splendidus (Herre 1927)	Manda In r
Carangidae	**Jacks**
Alectis ciliaris (Bloch 1787)	Africa cm. sou
Alectis indicus (Rüppell 1830)	Indian 150 Sea
Alepes djedaba (Forsskål 1775)	Shrim Ref sou
Alepes melanoptera Swainson 1839	Blackf Mu sou
Alepes vari (Cuvier 1833)	Herrin Mu Stra
Atropus atropos (Bloch & Schneider 1801)	Cleftb
Atule mate (Cuvier 1833)	Yellow 152 sou
Carangoides armatus (Rüppell 1830)	Longf Ma
Carangoides bajad (Forsskål 1775)	Orang Ma

Table 2. Continuation.
[Tabel 2. Sambungan.]

	152114 (TGT3002). Found from Bali Strait to Timor Sea (Ref. 5978).
Carangoides caeruleopinnatus (Ruppell 1830)	Coastal trevally, (M, Fi, Sport), Ref. 3287. Max. 36 cm FL. Museum: LPPL JIF173 (TGT2396); LPPL JIF220 (TGT 3296) (as C. uii)From southwest Sumatra to Bali Strait (Ref. 5978).
Carangoides chrysophrys (Cuvier 1833)	Longnose trevally, (M, Br, Fi), Ref. 3280. Max. 60 cm TL. Museum: LPPL JIF174 (TGT2245). Found from southwest Sumatra to Timor Sea (Ref. 5978).
Carangoides dinema Bleeker 1851	Shadow trevally, (M, Br, Fi, Sport), Ref. 3287. Max. 59 cm TL. Found from southwest Sumatra to Timor Sea (Ref. 5978).
Carangoides ferdau (Forsskål 1775)	Blue trevally, (M, Br, Fi, Sport), Ref. 3287. Max. 70 cm TL. Also Ref.: 8631. Museum: LPPL JIF175 (TGT3041). From Bali Strait to Timor Sea (Ref. 5978).
Carangoides fulvoguttatus (Forsskål 1775)	Yellowspotted trevally, (M, Fi, Sport), Ref. 3287. Max. 100 cm FL. Found from southwest Sumatra to Timor Sea (Ref. 5978).
Carangoides gymnostethus (Cuvier 1833)	Bludger, (M, Fi, Sport), Ref. 3287. Max. 90 cm TL.
Carangoides hedlandensis (Whitley 1934)	Bumpnose trevally, (M, Fi), Ref. 3287. Max. 28 cm FL. Museum: LPPL JIF176, from southwest Sumatra to Timor Sea (Ref. 5978).
Carangoides humerosus (McCulloch 1915)	Duskyshoulder trevally, (M, Fi), Ref. 3132. Max. 25 cm TL.
Carangoides malabaricus (Bloch & Schneider 1801)	Malabar trevally, Kwee, (M, Fi, Sport), Ref. 3280. Max. 60 cm. Also Ref.: 6567. Museum: LPPL JIF177, from southwest Sumatra to Timor Sea (Ref. 5978).
Carangoides oblongus (Cuvier 1833)	Coachwhip trevally, (M, Fi, Sport), Ref. 3287. Max. 46 cm TL.
Carangoides orthogrammus (Jordan & Gilbert 1882)	Island trevally, (M, Fi, Sport), Ref. 3287. Max. 63 cm FL. Museum: LPPL JIF204, from Bali Strait to Timor Sea (Ref. 5978).
Carangoides plagiotaenia Bleeker 1857	Barcheek trevally, (M, Fi, Sport), Ref. 3287. Max. 50 cm. Museum: LPPL JIF178, from southwest Sumatra to Bali Strait (Ref. 5978).
Carangoides praeustus (Bennett 1830)	Brownback trevally, (M, Fi, Sport), Ref. 3287. Max. 19.5 cm FL.
Carangoides talamparoides Bleeker 1852	Imposter trevally, (M, Fi), Ref. 3287. Max. 28 cm FL. Museum: LPPL JIF179, from southwest Sumatra to Timor Sea (Ref. 5978).
Caranx bucculentus Alleyne & Macleay 1877	Bluespotted trevally, (M, Br, Fi, Sport), Ref. 2334. Max. 66 cm.
Caranx heberi (Bennett 1830)	Blacktip trevally, (M, Br, Fi, Sport), Ref. 4537. Max. 85 cm. Also Ref.: 8631(Bali), 3287 and 3197 (as C. sem).
Caranx ignobilis (Forsskål 1775)	Giant trevally, (M, Fi, Sport), Ref. 3280. Max. 165 cm TL. Museum: LPPL JIF180 (TGT3136). From southwest Sumatra to Timor Sea (Ref. 5978). Also Ref.: 7050.
Caranx kleinii (Bloch 1793)	Banded scad, (M, Fi), Ref. 4537. Max. 16 cm FL. Museum: LPPL JIF216 (TGT2120). From southwest Sumatra to Timor Sea, as C. para (Ref. 5978). Also Ref.: 3287, as *C. para*.

Caranx melampygus Cuvier 1833	Bluefi cm Su
Caranx papuensis Alleyne & MacLeay 1877	Brass Ma
Caranx sexfasciatus Quoy & Gaimard 1825	Bigey cm 59
Caranx tille Cuvier 1833	Tille t Mu Tir
Decapterus kurroides Bleeker 1855	Redta Mu Ba
Decapterus macarellus (Cuvier 1833)	Mack cm Su
Decapterus macrosoma Bleeker 1851	Short Mu Su
Decapterus russelli (Rüppell 1830)	India Mu Ba
Elagatis bipinnulata (Quoy & Gaimard 1825)	Rainb Als so
Gnathanodon speciosus (Forsskål 1775)	Gold FL so
Megalaspis cordyla (Linnaeus 1758)	Torpe Mu Su
Naucrates ductor (Linnaeus 1758)	Pilotf
Pantolabus radiatus (Macleay 1881)	Fring Ma
Parastromateus niger (Bloch 1795)	Black Re sc
Scomberoides commersonnianus Lacepède 1801	Talar cn 59
Scomberoides lysan (Forsskål 1775)	Doub M.
Scomberoides tala (Cuvier 1832)	Barre M Ti
Scomberoides tol (Cuvier 1832)	Need M Fr
Selar boops (Cuvier 1833)	Oxey M m 59
Selar crumenophthalmus	Bige

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

(Bloch 1793)	SL. Also Ref.: 6567. Museum: LPPL JIF187 (TGT2612). From southwest Sumatra to Timor Sea (Ref. 5978).
Selaroides leptolepis (Cuvier 1833)	Yellowstripe scad, (M, Fi), Ref. 3287. Max. 18.5 cm FL. Museum: ANSP 152026, from southwest Sumatra to Timor Sea (Ref. 5978).
Seriola dumerili (Risso 1810)	Greater amberjack, (M, Fi, Aq, Sport, Dan), Ref. 3397. Max. 190 cm TL. Museum: LPPL JIF188, from southwest Sumatra to Bali Strait (Ref. 5978).
Seriola rivoliana Valenciennes 1833	Almaco jack, (M, Fi, Sport, Dan), Ref. 3287. Max. 110 cm FL. Also Ref.: 8631. Museum: CSIRO CA2467, from Bali Strait to Timor Sea (Ref. 5978).
Seriolina nigrofasciata (Rüppell 1829)	Blackbanded trevally, (M, Fi, Sport), Ref. 3287. Max. 70 cm TL. Museum: LPPL JIF189 (TGT2443): From southwest Sumatra to Timor Sea (Ref. 5978).
Trachinotus africanus Smith 1967	Southern pompano, (M, Br, Fi, Sport), Ref. 3287. Max. 92 cm TL.
Trachinotus baillonii (Lacepède 1801)	Smallspotted dart, (M, Br, Fi), Ref. 3287. Max. 60 cm TL.
Trachinotus blochii (Lacepède 1801)	Snubnose pompano, (M, Fi, Sport), Ref. 3280. Max. 110 cm FL.
Trachinotus botla (Shaw 1803)	Largespotted dart, (M, Br, Fi), Ref. 3197. Max. 75 cm TL.
Trachinotus mookalee Cuvier 1832	Indian pompano, (M, Fi, Sport), Ref. 3287. Max. 77 cm FL.
Ulua aurochs (Ogilby 1915)	Silvermouth trevally, (M, Fi), Ref. 4537. Max. 50 cm TL. Also Ref.: 3132.
Ulua mentalis (Cuvier 1833)	Longrakered trevally, (M, Fi, Sport), Ref. 3287. Max. 100 cm TL. Museum: LPPL JIF190 (TGT1372). From southwest Sumatra to Timor Sea (Ref. 5978).
Uraspis helvola (Forster 1801)	Whitemouth jack, (M, Fi, Sport), Ref. 3287. Max. 46 cm FL.
Uraspis uraspis (Günther 1860)	Whitetongue jack, (M, Fi), Ref. 3287. Max. 28 cm FL. Museum: LPPL JIF191, from southwest Sumatra to Bali Strait (Ref. 5978).
Centrogeniidae	
Centrogenys vaigiensis (Quoy & Gaimard 1824)	False scorpionfish, (M, Br), Ref. 8631. Known from Bali.
Centrolophidae	**Medusafishes**
Psenopsis obscura Haedrich 1967	Obscure ruff, (M), Ref. 4410. Max. 20 cm. Museum: BMNH 1984.1.1.96, BMNH 1984.1.1.97, from southwest Sumatra to Bali Strait (Ref. 5978).
Centropomidae	**Snooks**
Lates calcarifer (Bloch 1790)	Barramundi, Kakap, (M, Br, Fr, Fi, Aq, Sport), Ref. 3281 Max. 200 cm TL.
Psammoperca waigiensis (Cuvier 1828)	Waigieu seaperch, (M, Br), Ref. 9799. Max. 47 cm TL.
Cepolidae	**Bandfishes**
Acanthocepola abbreviata (Valenciennes 1853)	Bandfish, (M), Ref. 5978. Museum: ANSP 152037 (TGT917). From Bali Strait to Timor Sea.
Acanthocepola krusensterni (Temminck & Schlegel 1845)	(M), Ref. 5978. Max. 40 cm TL. Museum: ANSP 152036 (TGT2462). From southwest Sumatra to Bali Strait.
Cepola schlegelii Bleeker 1854	(M), Ref. 5978. Max. 50 cm TL. From southwest Sumatra to Bali Strait.

Owstonia pectinifer (Myers 1939)	(M, S Ba
Owstonia totomiensis Tanaka 1908	(M, F Mu Ba
Chaetodontidae	**Butte**
Chaetodon adiergastos Seale 1910	Philip Als
Chaetodon assarius Waite 1905	West cm Au up
Chaetodon aureofasciatus Macleay 1878	Golde Als
Chaetodon auriga Forsskål 1775	Threa Kn
Chaetodon baronessa Cuvier 1831	Easte cm 006
Chaetodon bennetti Cuvier 1831	Bluela Ma Flo
Chaetodon citrinellus Cuvier 1831	Speck Mu Tim
Chaetodon collare Bloch 1787	Redta
Chaetodon decussatus Cuvier 1831	Indian cm. LPF Sea
Chaetodon ephippium Cuvier 1831	Saddl Mu Tim
Chaetodon guentheri Ahl 1923	Croch Also (TG Sea
Chaetodon guttatissimus Bennett 1823	Peppe Kno
Chaetodon kleinii Bloch 1790	Sunbu Mus Tim
Chaetodon lunulatus Quoy & Gaimard 1825	(M), R
Chaetodon melannotus Bloch & Schneider 1801	Blackb Also Fror
Chaetodon meyeri Bloch & Schneider 1801	Scrawl Kno
Chaetodon ocellicaudus Cuvier 1831	Spotta
Chaetodon ornatissimus Solander 1831	Ornate Kno

Table 2. Continuation.
[Tabel 2. Sambungan.]

Chaetodon oxycephalus Bleeker 1853	Spot-nape butterflyfish, (M), Ref. 8631. Max. 25 cm TL. Known from Bali.
Chaetodon punctatofasciatus Cuvier 1831	Spotband butterflyfish, (M), Ref. 8631. Max. 9.6 cm SL. Also Ref.: 4537. In range Ref.: 1602. Known from Flores.
Chaetodon rafflesii Bennett 1830	Latticed butterflyfish, (M), Ref. 8631. Max. 15 cm TL. Known from Bali.
Chaetodon selene Bleeker 1853	Yellowdotted butterflyfish, (M), Ref. 5978. Max. 18 cm TL. Also Ref.: 8631. Museum: LPPL JIF105 (TGT3227). From Bali Strait to Timor Sea.
Chaetodon semeion Bleeker 1855	Pec, (M), Ref. 8631. Max. 25.5 cm TL. Known from Flores.
Chaetodon speculum Cuvier 1831	Mirror butterflyfish, (M), Ref. 4859. Max. 15 cm TL. Also Ref.: 8631.
Chaetodon triangulum Cuvier 1831	Triangle butterflyfish, (M), Ref. 4858. Max. 15 cm.
Chaetodon trifascialis Quoy & Gaimard 1824	Chevron butterflyfish, (M), Ref. 5978. Max. 18 cm TL. Also Ref.: 8631. Museum: LPPL JIF107 (TGT1096). From Bali Strait to Timor Sea.
Chaetodon ulietensis Cuvier 1831	Pacific doublesaddle butterflyfish, (M), Ref. 8631. Max. 15 cm TL. In range Ref.: 1602.
Chaetodon vagabundus Linnaeus 1758	Vagabond butterflyfish, (M), Ref. 8631. Max. 18 cm TL. Known from Bali.
Chaetodon xanthurus Bleeker 1857	Pearlscale butterflyfish, (M), Ref. 8631. Max. 14 cm SL. Known from Flores.
Coradion altivelis McCulloch 1916	Highfin coralfish, (M), Ref. 4855. Max. 9.1 cm SL.
Coradion chrysozonus (Cuvier 1831)	Goldengirdled coralfish, (M), Ref. 5978. Max. 11.5 cm SL. Museum: CSIRO CA998. From southwest Sumatra to Timor Sea.
Coradion melanopus (Cuvier 1831)	Twospot coralfish, (M), Ref. 4537. Max. 15 cm TL. Flores (Ref. 8631).
Forcipiger flavissimus Jordan & McGregor 1898	Longnose butterfly fish, (M), Ref. 8631. Max. 17.5 cm SL. Known from Flores.
Forcipiger longirostris (Broussonet 1782)	Longnose butterflyfish, (M), Ref. 8631. Max. 17.9 cm SL. Known from Flores.
Hemitaurichthys polylepis (Bleeker 1857)	Pyramid butterflyfish, (M), Ref. 1602. Max. 12.7 cm SL. Also Ref.: 8631.
Heniochus acuminatus (Linnaeus 1758)	Pennant coralfish, (M), Ref. 4859. Max. 20.5 cm SL. Museum: LPPL JIF108 (TGT3121). From southwest Sumatra to Timor Sea (Ref. 5978).
Heniochus chrysostomus Cuvier 1831	Threeband pennantfish, (M), Ref. 5978. Max. 12.5 cm SL. Museum: LPPL JIF109 (TGT1547). From Bali Strait To Timor Sea.
Heniochus diphreutes Jordan 1903	False moorish idol, (M), Ref. 5978. Max. 20 cm SL. Museum: CSIRO CA1504. From southwest Sumatra to Timor Sea.
Heniochus monoceros Cuvier 1831	Masked bannerfish, (M), Ref. 4859. Max. 30 cm TL.
Heniochus pleurotaenia Ahl 1923.	Phantom bannerfish, (M), Ref. 4855. Max. 16 cm TL. West coast of Sumatra.
Heniochus singularius Smith & Radcliffe 1911	Singular bannerfish, (M), Ref. 5978. Max. 23.7 cm SL. Also Ref.: 8631. Museum: LPPL JIF96 (TGT1025). From Bali Strait to Timor Sea.
Heniochus varius	Horned bannerfish, (M), Ref. 1602. Max. 15.2 cm SL.

(Cuvier 1829)	
Parachaetodon ocellatus (Cuvier 1831)	Sixsp Mu Ba
Champsodontidae	
Champsodon arafurensis Regan 1908	(M), Fr
Champsodon capensis Regan 1908	Gape Mu Fr 66
Champsodon guentheri Regan 1908	(M), Su
Champsodon longipinnis Matsubara & Amaoka 1964	(M), (T
Chiasmodontidae	
Pseudoscopelus altipinnis Parr 1933	(M, S Fr
Cichlidae	**Cich**
Oreochromis mossambicus (Peters 1852)	Moza 17
Cirrhitidae	**Hawl**
Amblycirrhitus bimacula (Jenkins 1903)	Twos
Cirrhitichthys aprinus (Cuvier 1829)	Spott Mu (R
Cirrhitichthys aureus (Temminck & Schlegel 1843)	Yello Mu Ba
Cirrhitichthys falco Randall 1963	Dwar Re
Cirrhitichthys oxycephalus (Bleeker 1855)	Cora Kr
Cirrhitus pinnulatus (Forster 1801)	Stock
Cyprinocirrhites polyactis (Bleeker 1875)	Swal Re S. Se
Oxycirrhites typus Bleeker 1857	Long Kr
Paracirrhites arcatus (Cuvier 1829)	Arc-e
Paracirrhites forsteri (Schneider 1801)	Black Re St
Coryphaenidae	**Dolp**
Coryphaena equiselis Linnaeus 1758	Pomp
Coryphaena hippurus Linnaeus 1758	Com Ma
Creediidae	**Sand**
Limnichthys fasciatus	(M

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Waite 1904	
Draconettidae	
Centrodraco insolitus (McKay 1971)	(M), Ref. 5978. Museum: SF P514-1984-003 (TGT1709). From Bali Strait to Timor Sea.
Drepanidae	**Sicklefishes**
Drepane longimana (Bloch & Schneider 1801)	Concertina fish, (M, Br), Ref. 9800. Max. 50 cm TL. Museum: NTM S.11016-005 (TGT2461). From southwest Sumatra to Timor Sea (Ref. 5978).
Drepane punctata (Linnaeus 1758)	Spotted sicklefish, (M, Br, Fi), Ref. 9800. Max. 45 cm TL. Museum: LPPL JIF93 (TGT2247). From southwest Sumatra to Timor Sea (Ref. 5978).
Echeneidae	**Remoras**
Echeneis naucrates Linnaeus 1758	Live sharksucker, (M, Sport), Ref. 5978. Max. 110 cm. Also Ref.: 8631. Museum: WAM P.26220-006. From southwest Sumatra to Timor Sea.
Remora remora (Linnaeus 1758)	Common remora, (M), Ref. 5978. Max. 86 cm TL. Museum: NTM S.10730-003 (TGT1501). From Bali Strait to Timor Sea.
Eleotridae	**Sleepers**
Belobranchus belobranchus Valenciennes 1837	(M, Br, Fr), Ref. 7050. Max. 19.5 cm TL. Known from Nias, Java, Sulawesi, Lesser Sundas, and Moluccas.
Butis amboinensis (Bleeker 1853)	Olive flathead-gudgeon, (M, Br, Fr), Ref. 7050. Max. 13.6 cm TL.
Eleotris acanthopoma Bleeker 1853	(M, Br, Fr), Ref. 7050. Max. 11.8 cm SL.
Emmelichthyidae	**Rovers**
Erythrocles schlegelii (Richardson 1846)	Japanese rubyfish, (M), Ref. 5978. Max. 50 cm. Museum: BMNH 1984.1.1.68 (TGT (PJPW) 846). From southwest Sumatra to Bali Strait.
Ephippidae	**Spadefishes, batfishes and scats**
Ephippus orbis (Bloch 1787)	Orbfish, (M, Fi), Ref. 5978. Max. 25 cm TL. Museum: NTM S.11001-004. From southwest
Sumatra	to Timor Sea.
Platax batavianus Cuvier 1831	Humpback batfish, (M), Ref. 5978. Max. 50 cm TL. Museum: LPPL JIF94 (TGT2450). From southwest Sumatra to Timor Sea.
Platax boersii Bleeker 1852	(M), Ref. 9407. Max. 40 cm TL.
Platax orbicularis (Forsskål 1775)	Batfish, (M, Br), Ref. 5978. Max. 50 cm. Also Ref.: 8631. From southwest Sumatra to Bali Strait.
Platax pinnatus (Linnaeus 1758)	Dusky batfish, (M), Ref. 8631. Max. 37 cm SL. Also Ref.: 4537. Known from Flores and Bali.
Platax teira (Bloch & Schneider 1801)	Longfin batfish, (M, Fi), Ref. 5978. Max. 41 cm SL. Also Ref.: 8631. Museum: LPPL JIF95 (TGT2440). From southwest Sumatra to Bali Strait; including Flores.
Zabidius novemaculeatus (McCulloch 1916)	Ninespine batfish, (M), Ref. 4537. Max. 45 cm TL.
Gempylidae	**Snake mackerels**
Diplospinus multistriatus Maul 1948	Striped escolar, (M), Ref. 6181. Max. 33 cm SL.
Gempylus serpens Cuvier 1829	Snake mackerel, (M, Fi), Ref. 6181. Max. 100 cm SL. Museum: NTM S.11118-001, from Bali Strait to Timor Sea (Ref. 5978).
Lepidocybium flavobrunneum (Smith 1843)	Escol. Mu Bal
Nealotus tripes Johnson 1865	Black
Neoepinnula orientalis (Gilchrist & von Bonde 1924)	Sackf
Nesiarchus nasutus Johnson 1862	Black
Promethichthys prometheus (Cuvier 1832)	Roudi Mu (Re
Rexea bengalensis (Alcock 1894)	Benga
Rexea nakamurai Parin 1989	Nakar
Rexea prometheoides (Bleeker 1856)	Royal Mu NTI Sea
Ruvettus pretiosus Cocco 1834	Oilfish
Thyrsitoides marleyi Fowler 1929	Black Mu Tim
Gerreidae	**Mojar**
Gerres abbreviatus Bleeker 1850	Deep- SL. Tim
Gerres acinaces Bleeker 1854	Longta Fro Als
Gerres filamentosus Cuvier 1829	Whipfi cm sou
Gerres kapas Bleeker 1851	Singa Mus Stra
Gerres oyena (Forsskål 1775)	Comm Mus Stra
Gerres poieti Cuvier 1829	Strong cm.
Pentaprion longimanus (Cantor 1850)	Longfi 656 (PJI (Re
Gobiidae	**Gobie**
Amblyeleotris diagonalis Polunin & Lubbock 1979	(M), R
Amblyeleotris fasciata (Herre 1953)	Red-b
Amblyeleotris fontanesii (Bleeker 1852)	Giant Also
Amblyeleotris guttata	Spotte

Table 2. Continuation.
[Tabel 2. Sambungan.]

(Fowler 1938)	Known from Flores.
Amblyeleotris gymnocephala (Bleeker 1853)	Masked shrimp-goby (M), Ref. 6771. Max. 14 cm TL. From Java. Also from Flores (Ref. 8631).
Amblyeleotris periophthalmus (Bleeker 1853)	(M), Ref. 2334. Max. 7.5 cm SL. Also Ref.: 8631. Known from Bali.
Amblyeleotris randalli Hoese & Steene 1978	Randall's prawn-goby, (M), Ref. 1602. Max. 7.3 cm SL. Also Ref.: 8631. Known from Flores and the Moluccas.
Amblyeleotris steinitzi (Klausewitz 1974)	Steinitz' prawn-goby, (M), Ref. 8631. Max. 8 cm. Known from Flores.
Amblyeleotris wheeleri (Polunin & Lubbock 1977)	Gorgeous prawn-goby, (M), Ref. 8631. Max. 6.5 cm SL. Known from Bali.
Amblygobius albimaculatus (Rüppell 1830)	Butterfly goby, (M, Br), Ref. 4343. Max. 18 cm SL.
Amblygobius decussatus (Bleeker 1855)	Orange-striped goby, (M), Ref. 1602. Max. 5.3 cm SL. Also Ref.: 8631. Known from Flores.
Amblygobius nocturnus (Herre 1945)	Nocturn goby, (M), Ref. 8631. Max. 4.1 cm SL. Known from Flores.
Amblygobius phalaena (Valenciennes 1837)	Banded goby, (M), Ref. 8631. Max. 12 cm SL. Known from Bali.
Amblygobius rainfordi (Whitley 1940)	Old glory, (M), Ref. 8631. Max. 6.5 cm TL. Known from Flores.
Amblygobius sphynx (Valenciennes 1837)	Sphinx goby, (M, Br), Ref. 2334. Max. 18 cm.
Apocryptodon madurensis (Bleeker 1849)	(M), Ref. 5218. Max. 7.1 cm SL.
Bathygobius fuscus (Rüppell 1830)	Dusky frill-goby, (M, Br, Fr), Ref. 1602. Max. 12 cm TL.
Bathygobius padangensis (Bleeker 1851)	(M), Ref. 559.
Bathygobius petrophilus (Bleeker 1853)	(M), Ref. 559.
Boleophthalmus boddarti (Pallas 1770)	Boddart's goggle-eyed goby, (M, Br, Fr), Ref. 7050. Max. 22 cm TL. Kalimantan, Sumatra, and Java (Ref. 7050).
Bryaninops tigris Larson 1985	Black coral goby, (M), Ref. 8631. Max. 5.5 cm SL. Known from Bali.
Bryaninops yongei (Davis & Cohen 1969)	Whip coral goby, (M), Ref. 8631. Max. 2.8 cm SL. Known from Flores.
Callogobius centrolepis Weber 1909	(M), Ref. 1602. Max. 4 cm SL.
Callogobius snelliusi Koumans 1953	(M), Ref. 559.
Cryptocentroides insignis (Seale 1910)	Insignia prawn-goby, (M, Br), Ref. 1602. Max. 6.9 cm SL.
Cryptocentrus cinctus (Herre 1936)	Yellow-prawn goby, (M), Ref. 1602. Max. 7.5 cm. Also Ref. 8631. Known from Flores.
Cryptocentrus fasciatus (Playfair & Günther 1867)	Y-bar shrimp goby, Black shrimp-goby, (M), Ref. 2334. Max. 8 cm TL. From Flores (Ref. 8631).
Cryptocentrus leucostictus (Günther 1871)	Saddled prawn-goby, (M), Ref. 2334. Max. 7 cm TL.
Cryptocentrus octofasciatus Regan 1908	Blue-speckled prawn goby, (M), Ref. 8631. Max. 4.5 cm SL. Known from Flores.

Cryptocentrus strigilliceps (Jordan & Seale 1906)	Targe Kr
Ctenogobiops aurocingulus (Herre 1935)	Gold SL
Ctenogobiops feroculus Lubbock & Polunin 1977	Sanc Kr
Ctenogobiops pomastictus Lubbock & Polunin 1977	Gold- SL
Ctenogobiops tangaroae Lubbock & Polunin 1977	Tang: Flc
Ctenotrypauchen microcephalus (Bleeker 1860)	(M, B
Eviota afelei Jordan & Seale 1906	Afele
Eviota bifasciata Lachner & Karanella 1980	Twos Als
Eviota herrei Jordan & Seale 1906	Herre
Eviota lachdeberei Giltay 1933	Lachc SL
Eviota melasma Lachner & Karnella 1980	Melas
Eviota nebulosa Smith 1958	Nebul
Eviota nigriventris Giltay 1933	(M), F Knc
Eviota pellucida Larson 1976	Pelluc Knc
Eviota prasina (Klunzinger 1871)	Greer
Eviota prasites Jordan & Seale 1906	Prasit Als
Eviota punctulata Jewett & Lachner 1983	Peppe
Eviota queenslandica Whitley 1932	Queer SL.
Eviota sebreei Jordan & Seale 1906	Sebre Knc
Eviota sparsa Jewett & Lachner 1983	(M), R
Eviota spilota Lachner & Karnella 1980	(M), R
Eviota storthynx (Rofen 1959)	(M), R
Eviota zonura Jordan & Seale 1906	(M), R
Exyrias belissimus (Smith 1959)	Mud re
Exyrias puntang (Bleeker 1851)	Puntar
Fusigobius longispinus Goren 1978	Orang TL.
Fusigobius neophytus (Günther 1877)	Comm fron

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Fusigobius signipinnis Hoese & Obika 1988	(M), Ref. 5261 Max. 4.9 cm SL.
Gnatholepis cauerensis (Bleeker 1853)	Eyebar goby, (M, Br), Ref. 4343. Max. 8 cm TL.
Gnatholepis scapulostigma Herre 1953	Shoulderspot goby, Eye-bar sand-goby, (M), Ref. 2334. Max. 5.5 cm TL. From Flores (Ref. 8631).
Gobiodon histrio (Valenciennes 1837)	Broad-barred goby, (M), Ref. 2334. Max. 3.5 cm.
Gobiodon okinawae Sawada, Arai & Abe 1972	Okinawa goby, Yellow-speckled cave-goby, (M), Ref. Known from Waigiu, Irian Jaya.Known from Waigiu, Irian Jaya.1602. Max. 3.5 cm TL.
Gobiopsis bravoi (Herre 1940)	(M), Ref. 11081. Known from Waigiu, Irian Jaya. Also Ref.: 1602.
Istigobius decoratus (Herre 1927)	Decorated goby, (M), Ref. 420. Max. 13 cm TL. Museum: Moluccas, USNM 254306, 254307.
Istigobius goldmanni (Bleeker 1852)	(M), Ref. 420. Max. 5 cm TL. Also Ref.: 8631. Museum: Moluccas, USNM 211078.
Istigobius nigroocellatus (Günther 1873)	Black-spotted goby, (M), Ref. 8631. Max. 4.9 cm TL. Known from Flores.
Istigobius ornatus (Rüppell 1830)	Ornate goby, (M, Br), Ref. 420. Max. 8 cm SL. Also Ref.: 8631. Known from Sumatra and Java.
Istigobius rigilius (Herre 1953)	Rigilius goby, (M), Ref. 420. Max. 7.9 cm SL. Also Ref.: 8631. Museum: Sulawesi (Celebes), USNM 254295. Also known from Flores.
Macrodontogobius wilburi Herre 1936	Largetooth goby, (M), Ref. 403. Max. 5.2 cm SL.
Mahidolia mystacina (Valenciennes 1837)	Flagfin prawn goby, (M, Br), Ref. 4343. Max. 6.5 cm SL. Also Ref.: 8631. Known from Flores.
Odontamblyopus rubicundus (Hamilton 1822)	(M, Br), Ref. 7050. Max. 22 cm TL. In range Ref.: 4833.
Oligolepis acutipennis (Valenciennes 1837)	Sharptail goby, (M, Br), Ref. 4343. Max. 15 cm TL.
Oplopomus oplopomus (Valenciennes 1837)	Spinecheek goby, (M), Ref. 8631. Max. 8 cm. Known from Flores.
Oxyurichthys ophthalmonema (Bleeker 1856-57)	Eyebrow goby, (M, Br, Fr), Ref. 5978. Max. 18 cm TL. From Bali Museum: NTM S.10733-002 (TGT1076). Strait to Timor Sea. In range Ref.: 2798.
Papillogobius reichei (Bleeker 1853)	(M, Br, Fr), Ref. 7050. Max. 8.3 cm TL.
Periophthalmodon freycineti Valenciennes 1837	(M), Ref. 5218.
Periophthalmus argentilineatus Valenciennes 1837	Barred mudskipper, (M, Br), Ref. 5218. Max. 19 cm TL.
Periophthalmus gracilis Eggert 1935	(M), Ref. 5218.
Periophthalmus malaccensis Eggert 1935	(M, Br, Fr), Ref. 5218.
Periophthalmus minutus Eggert 1935	(M), Ref. 5218.
Platygobiopsis akihito Springer & Randall 1992	(M, En), Ref. 8935. Max. 9.64 cm SL. Museum: USNM 309181 (Maumere Bay off Sao Wisata Resort), AMS I.31467-001, BMNH 1991.5.7:1, BPBM 32817, CAS 760055, NSMT-P 34720, ROM 61628, USNM 309197, NTM S. 13009-001, USNM 316643.

Pleurosicya bilobatus (Koumans 1941)	(M), Ref.
Pleurosicya elongata Larson 1990	Cling gol
Priolepis fallacincta Winterbottom & Burridge 1992	(M), Ref.
Priolepis semidoliatus (Valenciennes 1837)	(M), Ref. Waigu
Scartelaos histophorus (Valenciennes 1837)	Walking
Signigobius biocellatus Hoese & Allen 1977	Twinspot Ref.: 8
Stenogobius genivittatus (Valenciennes 1837)	(M, Br, F
Stonogobiops nematodes Hoese & Randall 1982	(M), Ref
Stonogobiops xanthorhinica Hoese & Randall 1982	Yellownc 8631. Nusar Nusa
Trimma okinawae (Aoyagi 1949)	Okinawa Also F
Valenciennea helsdingenii (Bleeker 1858)	Twostrip Ref.:
Valenciennea longipinnis (Lay & Bennett 1839)	Long-fin Also Putri, 1610 Borne
Valenciennea muralis (Valenciennes 1837)	Mural gc 8631. 2110 149; l Aru Is
Valenciennea puellaris (Tomiyama 1955)	Maiden Ref.: Kaba P.252
Valenciennea randalli Hoese and Larson 1994	(M), Ref
Valenciennea sexguttata (Valenciennes 1837)	Sixspot 8527 Ment Suma
Valenciennea strigata (Broussonet 1782)	Bluebar Ref.: Sea, Celet USNI
Vanderhorstia ambanoro (Fourmanoir 1957)	Ambanc SL. K
Yongeichthys nebulosus (Forrskål 1775)	Shadov Max. Flore

Table 2. Continuation.
[Tabel 2. Sambungan.]

Haemulidae	**Grunts**
Diagramma pictum (Thunberg 1792)	Painted sweetlips, (M, Fi, Sport, Dan), Ref. 2112. Max. 100 cm FL. Also Ref.: 6567. Museum: CSIRO CA1649 (conspecific material). From southwest Sumatra to Timor Sea (Ref. 5978).
Diagramma punctatum Cuvier 1830	(M), Ref. 5978. Museum: NTM S.11037-001 (TGT2444). From southwest Sumatra to Timor Sea.
Plectorhinchus albovittatus (Rüppell 1835)	Two-stripe sweetlips, (M), Ref. 1602. Max. 250 cm SL.
Plectorhinchus celebicus Bleeker 1873	Celebes sweetlips, (M, Fi), Ref. 160. Max. 41 cm SL. Museum: BPBM 29335, from Bali Strait to Timor Sea (Ref. 5978).
Plectorhinchus chaetodonoides Lacepède 1801	Harlequin sweetlips, (M), Ref. 8631. Max. 60 cm SL. In range Ref.: 1602. From southwest Sumatra to Bali Strait (Ref. 5978). Also known from Flores.
Plectorhinchus chubbi (Regan 1919)	Dusky rubberlips, (M), Ref. 5978. Max. 75 cm. Museum: LPPL JIF74 (TGT900). From Bali Strait to Timor Sea.
Plectorhinchus flavomaculatus (Ehrenberg 1830)	Lemonfish, (M, Fi), Ref. 5978. Max. 60 cm. From southwest Sumatra to Timor Sea.
Plectorhinchus gaterinoides (Cuvier 1830)	Lined sweetlips, (M), Ref. 8631. Max. 40 cm SL. Known from Flores.
Plectorhinchus gibbosus (Lacepède 1802)	Harry hotlips, (M, Br, Fr, Sport), Ref. 5978. Max. 75 cm. Museum: WAM P.26218-004. From southwest Sumatra to Timor Sea. Also Ref.: 7050.
Plectorhinchus goldmanni (Bleeker 1853)	Goldman's sweetlips, (M), Ref. 1602. Max. 60 cm SL. Museum: LPPL JIF75, from Bali Strait to Timor Sea (Ref. 5978).
Plectorhinchus lineatus (Cuvier 1830)	Yellowbanded sweetlips, (M, Br, Fr), Ref. 5978. Max. 30 cm SL. Museum: BPBM 29350 (TGT2123). From Bali Strait to Timor Sea.
Plectorhinchus obscurum (Günther 1871)	Giant sweetlips, (M), Ref. 5978. Max. 83 cm SL. Museum: BPBM 29349 (TGT1239). From Bali Strait to Timor Sea.
Plectorhinchus orientalis (Bloch 1793)	Oriental sweetlips, (M, Sport), Ref. 5978. Max. 72 cm SL. Also Ref.: 8631. Museum: BPBM 29336 (TGT1357). From Bali Strait to Timor Sea. Also known from Flores.
Plectorhinchus picus (Cuvier 1830)	Painted sweetlip, (M, Fi), Ref. 3412. Max. 70 cm SL. Museum: QM I.20291, from Bali Strait to Timor Sea (Ref. 5978).
Plectorhinchus polytaenia (Bleeker 1852)	Ribboned sweetlips, (M), Ref. 5978. Max. 40 cm. Also Ref.: 8631. Museum: LPPL JIF72. From Bali Strait to Timor Sea (Ref. 5978).
Pomadasys argenteus (Forsskål 1775)	Silver grunt, (M, Br, Fi), Ref. 5978. Max. 52 cm. Museum: BPBM 29343. From southwest Sumatra to Timor Sea. Also Ref.: 7050.
Pomadasys argyreus (Valenciennes 1833)	Bluecheek silver grunt, (M), Ref. 5978. Max. 40 cm. Museum: LPPL JIF73. From southwest Sumatra to Timor Sea.
Pomadasys furcatus (Bloch & Schneider 1801)	Banded grunt, (M, Fi), Ref. 5978. Max. 50 cm. Museum: BPBM 29348 (TGT3028). From Bali Strait to Timor Sea.
Pomadasys kaakan	Javelin grunter, (M, Br), Ref. 5978. Max. 80 cm.

(Cuvier 1830)	Mu Su
Pomadasys maculatus (Bloch 1797)	Sadd Als (T (R
Pomadasys opercularis (Playfair & Günther 1866)	Smal
Istiophoridae	**Billfi**
Istiophorus platypterus (Shaw & Nodder 1792)	Indo- Ma
Makaira indica (Cuvier 1832)	Black
Makaira mazara (Jordan & Snyder 1901)	Indo- Ma
Tetrapturus angustirostris Tanaka 1914	Shor TL
Tetrapturus audax (Philippi 1887)	Strip TL
Kuhliidae	**Ahol**
Kuhlia marginata (Cuvier 1829)	Dark cm
Kuhlia mugil (Schneider 1801)	Barre cm
Kuhlia rupestris (Lacepède 1802)	Rock
Kurtidae	**Nurs**
Kurtus indicus Bloch 1786	India TL
Kyphosidae	**Sea**
Kyphosus cinerascens (Forssål 1775)	Blue Als St
Kyphosus vaigiensis (Quoy & Gaimard 1825)	Brass Als Se
Labridae	**Wras**
Anampses caeruleopunctatus Rüppell 1829	Blues Kr
Anampses geographicus Valenciennes 1840	Geog Kr
Anampses lineatus Randall 1972	Lined Ma
Anampses melanurus Bleeker 1857	White Als
Anampses meleagrides Valenciennes 1840	Yello Als
Anampses neoguinaicus Bleeker 1878	New
Anampses twistii Bleeker 1856	Yello Kr
Bodianus anthioides (Bennett 1832)	Lyret Ma
Bodianus axillaris (Bennett 1832)	Axils

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Bodianus bilunulatus (Lacepède 1801)	Tarry hogfish, (M, Sport), Ref. 5978. Max. 50 cm SL. Museum: NTM S.10735-003 (TGT1363). From Bali Strait to Timor Sea. Also Ref.: 8631.
Bodianus bimaculatus Allen 1973	Twospot hogfish, Yellow hogfish, (M), Ref. 1602 Max. 10 cm TL. Flores (Ref. 8631).
Bodianus diana (Lacepède 1801)	Diana's hogfish, (M), Ref. 8631. Max. 25 cm SL. Bali.
Bodianus mesothorax (Bloch & Schneider 1801)	Splitlevel hogfish, Black-belt hogfish, (M), Ref. 559. Max. 20 cm. Flores (Ref. 8631).
Cheilinus chlorourus (Bloch 1791)	Floral wrasse, (M), Ref. 2334. Max. 36 cm SL.
Cheilinus fasciatus (Bloch 1791)	Redbreasted wrasse, (M), Ref. 1602. Max. 40 cm SL.
Cheilinus oxycephalus Bleeker 1853	Snooty wrasse, Point-head maori, (M), Ref. 8631. Max. 14 cm SL. Known from Bali. In range Ref.: 1602, 2334.
Cheilinus trilobatus Lacepède 1801	Tripletail wrasse, Triple-tail maori, (M), Ref. 5978. Max. 40 cm SL. Museum: LPPL JIF119 (TGT909). From Bali Strait to Timor Sea. Also in Flores (Ref. 8631).
Cheilinus undulatus Rüppell 1835	Humphead wrasse, (M, Fi, Dan), Ref. 1602. Max. 229 cm SL.
Cheilio inermis (Forsskål 1775)	Cigar wrasse, (M), Ref. 5978. Max. 50 cm SL. Also Ref.: 8631. Museum: NTM S.10748-015 (TGT1004). From Bali Strait to Timor Sea.
Choerodon anchorago (Bloch 1791)	Orange-dotted tuskfish, White-belly tuskfish, (M), Ref. 2334. Max. 38 cm SL. Museum: NTM S.10741-001, from Bali Strait to Timor Sea (Ref. 5978). Also Ref.: 8631.
Choerodon cephalotes (Castelnau 1875)	Purple tuskfish, (M), Ref. 2334. Max. 38 cm TL.
Choerodon robustus (Günther 1862)	Robust tuskfish, (M), Ref. 5978. Max. 30 cm TL. From southwest Sumatra to Bali Strait.
Choerodon schoenleinii (Valenciennes 1839)	Blackspot tuskfish, (M, Sport), Ref. 5978. Max. 100 cm TL. From southwest Sumatra to Timor Sea.
Choerodon zamboangae (Seale & Bean 1907)	Purple eyebrowed tuskfish, (M), Ref. 5978. Museum: NTM S.10752-014 (TGT3238). From Bali Strait to Timor Sea.
Cirrhilabrus cyanopleura (Bleeker 1851)	Blueside wrasse, (M), Ref. 2745. Max. 15 cm SL. Also Ref.: 8631. Known from Flores.
Cirrhilabrus exquisitus Smith 1957	Exquisite wrasse, (M), Ref. 5278. Max. 12 cm SL. Also Ref.: 8631.
Cirrhilabrus filamentosus (Klausewitz 1976)	Whip-fin wrasse, (M), Ref. 5978. Max. 8 cm. Also Ref.: 8631. Museum: NTM S.10744-001 (TGT955). From Bali Strait to Timor Sea.
Cirrhilabrus lubbocki Randall & Carpenter 1980	Lubbock's wrasse, (M), Ref. 9823. Max. 7 cm SL. Recorded from Celebes.
Cirrhilabrus rubrimarginatus Randall 1992	(M), Ref. 5278. Max. 12.2 cm SL. Museum: off Sulawesi, Tukanbesi Group, Moromaho I., BPBM 34199. Bali, small bay NE of Padangbai, BPBM 30184, 31577.
Cirrhilabrus temminckii Bleeker 1853	Threadfin wrasse, (M), Ref. 8631. Max. 9.9 cm SL. Known from Bali.
Coris aygula Lacepède 1801	Clown wrasse, (M), Ref. 1602. Max. 120 cm TL.
Coris dorsomacula Fowler 1908	Pale
Coris gaimard gaimard (Quoy & Gaimard 1824)	Yellc Kı
Coris pictoides Randall & Kuiter 1982	Blacı Al
Coris variegata (Rüppell 1835)	Dapr frc
Diproctacanthus xanthurus (Bleeker 1856)	Yello Al: Gı
Epibulus insidiator (Pallas 1770)	Sling 54 Frı 86
Gomphosus varius Lacepède 1801	Bird \ fro
Halichoeres argus (Bloch & Schneider 1801)	Argus Re
Halichoeres binotopsis (Bleeker 1849)	(M), F
Halichoeres biocellatus Schultz 1960	Redlii Kr
Halichoeres chloropterus (Bloch 1791)	Paste Als
Halichoeres chrysus Randall 1981	Golde Als
Halichoeres dussumieri (Valenciennes 1839)	Bubbl Knı
Halichoeres hartzfeldii (Bleeker 1852)	Hartzf Als (TG
Halichoeres hortulanus (Lacepède 1801)	Check
Halichoeres margaritaceus (Valenciennes 1839)	Pink-b Alsı Fro
Halichoeres marginatus Rüppell 1835	Splenı TL.
Halichoeres melanurus (Bleeker 1851)	Tail-sp Ref
Halichoeres melasmapomus Randall 1980	Ocella Alsc
Halichoeres miniatus (Valenciennes 1839)	Circle- Alsc
Halichoeres nebulosus (Valenciennes 1839)	Nebulc Mus Sea
Halichoeres ornatissimus (Garrett 1863)	(M), Rı Kno
Halichoeres podostigma (Bleeker 1854)	Axil sp Also Florı
Halichoeres prosopeion (Bleeker 1853)	Twotor Also

Table 2. Continuation.
[Tabel 2. Sambungan.]

Halichoeres purpurescens (Bloch & Schneider 1801)	Silty wrasse, (M), Ref. 6023. Max. 12 cm TL. From Flores (Ref. 8631).
Halichoeres richmondi Fowler & Bean 1928	Richmond's wrasse, (M), Ref. 1602. Max. 13 cm SL. Also Ref.: 8631. Known from Moluccas and Flores.
Halichoeres scapularis (Bennett 1832)	Zigzag wrasse, (M), Ref. 8631. Max. 15.6 cm SL. Known from Bali.
Halichoeres solorensis (Bleeker 1853)	Green wrasse, (M), Ref. 6023. Max. 18 cm TL. From Flores (Ref. 8631).
Halichoeres timorensis (Bleeker 1852)	Timor wrasse, (M), Ref. 2136. Max. 7.8 cm SL. Also Ref.: 8631. Known from Bali.
Halichoeres trimaculatus (Quoy & Gaimard 1824)	Threespot wrasse, (M), Ref. 1602. Max. 22 cm SL.
Halichoeres zeylonicus Bennett 1832	Goldstripe wrasse, (M), Ref. 2334. Max. 20 cm.
Hemigymnus fasciatus (Bloch 1792)	Barred thicklip, (M), Ref. 8631. Max. 50 cm SL. Known from Bali and Flores.
Hemigymnus melapterus (Bloch 1791)	Blackeye thicklip, (M), Ref. 5978. Max. 71 cm SL. Also Ref.: 8631. Museum: LPPL JIF121 (TGT1551). From Bali Strait to Timor Sea.
Hologymnosus annulatus (Lacepède 1801)	Ring wrasse, (M), Ref. 2334. Max. 40 cm TL.
Hologymnosus doliatus (Lacepède 1801)	Pastel ringwrasse, (M), Ref. 8631. Max. 38 cm TL. Known from Flores.
Hologymnosus rhodonotus Randall & Yamakawa 1988	Redback longface wrasse, (M), Ref. 5277. Max. 27.4 cm SL. From Bali Strait to Timor (Ref. 5978). Museum: Bali, BPBM 31973.
Labrichthys unilineatus (Guichenot 1847)	Tubelip wrasse, (M), Ref. 2747. Max. 17.5 cm TL. Flores (Ref. 8631).
Labroides bicolor Fowler & Bean 1928	Bicolor cleaner wrasse, (M), Ref. 1602. Max. 9.8 cm SL.
Labroides dimidiatus (Valenciennes 1839)	Bluestreak cleaner wrasse, (M), Ref. 1602. Max. 11.5 cm TL. Also Ref.: 8631. Museum: NTM S.10736-001 (TGT1757). From southwest Sumatra to Timor Sea (Ref. 5978).
Labroides pectoralis Randall & Springer 1975	Blackspot cleaner wrasse, (M), Ref. 8631. Max. 6 cm SL. Known from Flores.
Labropsis alleni Randall 1981	Allen's tubelip, (M), Ref. 2137. Max. 8.2 cm SL. Also Ref.: 8631. Known from Flores. Museum: Molucca Is., Ambon, BPBM 19303.
Labropsis manabei Schmidt 1930	Northern tubelip, (M), Ref. 8631. Max. 11.7 cm SL. Known from Flores.
Labropsis xanthonota Randall 1981	Yellowback tubelip, (M), Ref. 2137. Max. 13 cm TL. Also Ref.: 8631. Known from Flores. Museum: Java, Seribu Is., Pulau Putri, BPBM 19522.
Leptojulis cyanopleura (Bleeker 1853)	Shoulder-spot wrasse, (M), Ref. 5978. Max. 13 cm TL. Also Ref.: 8631, 9823. Museum: AMS I.22806-019. From Bali Strait to Timor Sea. In range Ref.: 3132.
Macropharyngodon negrosensis Herre 1932	Yellowspotted wrasse, (M), Ref. 8631. Max. 10.2 cm SL. Known from Flores.
Macropharyngodon ornatus Randall 1978	Ornate wrasse, False leopard, (M), Ref. 6192. Max. 12 cm TL. Also from Flores (Ref. 8631). Museum: Molucca Is., Ambon, BPBM 18546 (Holotype).
Novaculichthys macrolepidotus (Bloch 1791)	Seagrass wrasse, (M), Ref. 1602. Max. 12 cm SL.
Novaculichthys taeniourus (Lacepède 1801)	Roc A (1 S
Oxycheilinus bimaculatus (Valenciennes 1840)	Two M S
Oxycheilinus celebicus (Bleeker 1853)	Cele M
Oxycheilinus digrammus (Lacepède 1801)	Che
Oxycheilinus orientalis (Günther 1862)	Orie M S
Oxycheilinus unifasciatus (Streets 1877)	Ring T
Paracheilinus carpenteri Randall & Lubbock 1981	Pink M S
Paracheilinus filamentosus Allen 1974	Filar A
Pseudocheilinops ataenia Schultz 1960	Pelv A C
Pseudocheilinus evanidus Jordan & Evermann 1903	Stria K
Pseudocheilinus hexataenia (Bleeker 1857)	Pyja Fl
Pseudocheilinus octotaenia Jenkins 1901	Eigh K
Pseudocoris heteroptera (Bleeker 1857)	Torp
Pseudocoris philippina (Fowler & Bean 1928)	Phili K
Pseudocoris yamashiroi (Schmidt 1930)	Red K
Pseudodax moluccanus (Valenciennes 1840)	Chis R (F
Pteragogus amboinensis (Bleeker 1856)	(M),
Pteragogus cryptus Randall 1981	Cryp M
Pteragogus flagellifer (Valenciennes 1839)	Cocl M S
Pteragogus guttatus (Fowler & Bean 1928)	(M),
Stethojulis bandanensis (Bleeker 1851)	Red
Stethojulis interrupta (Bleeker 1851)	Cutr M Ti

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Stethojulis strigiventer (Bennett 1832)	Three-ribbon rainbowfish, (M), Ref. 8631. Max. 15 cm TL. Known from Flores.
Stethojulis trilineata (Bloch & Schneider 1801)	Threeline rainbowfish, (M, Fi), Ref. 2334. Max. 15 cm TL. Also Ref.: 8631. Known from Flores.
Thalassoma amblycephalum (Bleeker 1856)	Bluntheaded wrasse, (M), Ref. 8631. Max. 16 cm SL. Known from Bali.
Thalassoma hardwickii (Bennett 1828-30)	Sixbar wrasse, (M), Ref. 8631. Max. 17 cm SL. Known from Bali.
Thalassoma jansenii (Bleeker 1856)	Jansen's wrasse, (M), Ref. 8631. Max. 17 cm SL. Known from Bali and Flores.
Thalassoma lunare (Linnaeus 1758)	Moon wrasse, (M), Ref. 8631. Max. 30 cm. Known from Bali.
Thalassoma purpureum (Forsskål 1775)	Surge wrasse, (M), Ref. 8631. Max. 46 cm. Known from Bali.
Thalassoma trilobatum (Lacepède 1801)	Christmas wrasse, (M), Ref. 1602. Max. 24 cm SL.
Wetmorella albofasciata Schultz & Marshall 1954	Whitebanded sharpnose wrasse, (M), Ref. 1602. Max. 4.6 cm SL.
Wetmorella nigropinnata (Seale 1901)	Sharpnose wrasse, (M), Ref. 2138. Max. 6.5 cm SL. Also Ref.: 8631.Known from Flores. Museum:Pulau Seribu, Java, USNM 231377. Marsegoe Bay, Moluccas, AMS I.18469-082. Ceram, USNM 209661, 210030. Kabaena I., USNM 236520. Huruku I., Moluccas, USNM 209587.
Xiphocheilus typus Bleeker 1856	Blue-banded wrasse, (M), Ref. 5978. Max. 12 cm SL. Museum: NTM S.11016-004 (TGT2473). From southwest Sumatra to Bali Strait.
Xyrichtys aneitensis (Günther 1862)	Yellowblotch razorfish, (M), Ref. 1602. Max. 20 cm SL. Also Ref.: 8631. Known from Bali.
Xyrichtys celebicus (Bleeker 1856)	Celebes razorfish, (M), Ref. 1602. Max. 16.1 cm SL.
Xyrichtys dea Temminck & Schlegel 1845	(M), Ref. 5978. Max. 30 cm TL. Museum: CSIRO CA2145. From Bali Strait to Timor Sea.
Xyrichtys pavo Valenciennes 1840	Peacock wrasse, (M, Sport), Ref. 5978. Max. 35 cm TL. Museum: NTM S.10745-002 (TGT1888). From southwest Sumatra to Timor Sea.
Xyrichtys pentadactylus (Linnaeus 1758)	Five-finger wrasse, (M), Ref. 5978. Max. 25 cm TL. Also Ref.: 8631. Museum: LPPL JIF123 (TGT1592). From Bali Strait to Timor Sea.
Xyrichtys twistii (Bleeker 1856)	(M), Ref. 559. Max. 20 cm SL.
Lactariidae	**False trevallies**
Lactarius lactarius (Bloch & Schneider 1801)	False trevally, (M, Fi), Ref. 6567. Max. 40 cm. Museum: LPPL JIF46 (TGT2503). From southwest Sumatra to Timor Sea (Ref. 5978).
Leiognathidae	**Slimys, slipmouths, or ponyfishes**
Gazza achlamys Jordan and Starks 1917	Smalltoothed ponyfish, (M, Br, Fi), Ref. 5978. Max. 15 cm SL. Museum: NTM S.11040-001 (TGT2504). From southwest Sumatra to Timor Sea.
Gazza minuta (Bloch 1797)	Toothpony, (M, Br, Fi), Ref. 5978. Max. 21 cm FL. Museum: NTM S.11031-003 (TGT2615). From southwest Sumatra to Timor Sea. Also Ref.: 7050.
Leiognathus bindus (Valenciennes 1835)	Orangefin ponyfish, (M, Br), Ref. 5978. Max. 11 cm. Museum: NTM S.10733-042 (TGT2108).

	From s
Leiognathus blochi (Valenciennes 1835)	Twoblotc TL.
Leiognathus decorus (De Vis 1844)	(M, Br), F 1984.1 Sumat
Leiognathus dussumieri (Valenciennes 1835)	Dussumi Max. 1
Leiognathus elongatus (Günther 1874)	Slender p Museu southv
Leiognathus equulus (Forsskål 1775)	Commor TL. Mu Sumat
Leiognathus fasciatus (Lacepède 1803)	Striped p Museu to Tim
Leiognathus leuciscus (Günther 1860)	Whipfin p Museu From s
Leiognathus rapsoni Munro 1964	Rapson's Museu From s
Leiognathus smithursti (Ramsay & Ogilby 1886)	Smithurs Museu From s
Leiognathus splendens (Cuvier 1829)	Splendid Also F southv
Leiognathus stercorarius Evermann & Seale 1907	Oblong s Museu to Bali
Secutor indicius Monkolprasit 1973	(M, Br), I JIF21 Sea. F 7050).
Secutor insidiator (Bloch 1787)	Pugnose SL. M southv Ref.: 6
Secutor ruconius (Hamilton 1822)	Deep pu Museu Suma
Lethrinidae	**Empero**
Gnathodentex aureolineatus (Lacepède 1802)	Striped la 30 cm southv
Gymnocranius elongatus Senta 1973	Forktail l TL. M Suma
Gymnocranius frenatus Bleeker 1873	Yellowsn Max. 3
Gymnocranius grandoculis (Valenciennes 1830)	Blue-line cm TL

Table 2. Continuation.
[Tabel 2. Sambungan.]

	from southwest Sumatra to Timor Sea (Ref. 5978).
Gymnocranius griseus (Temminck & Schlegel 1843)	Grey large-eye bream, (M, Fi), Ref. 2295. Max. 35 cm TL. Museum: LPPL JIF195 (TGT2369). From southwest Sumatra to Timor Sea (Ref. 5978).
Gymnocranius microdon (Bleeker 1851)	Blue-spotted large-eye bream, (M, Fi), Ref. 2295. Max. 45 cm TL.
Lethrinus amboinensis Bleeker 1854	Ambon emperor, (M, Fi), Ref. 2295. Max. 70 cm TL.
Lethrinus atkinsoni Seale 1910	Pacific yellowtail emperor, (M, Fi, Sport), Ref. 2295. Max. 45 cm TL.
Lethrinus conchyliatus (Smith 1959)	Redaxil emperor, (M, Fi), Ref. 2295. Max. 76 cm TL.
Lethrinus erythracanthus Valenciennnes 1830	Orange-spotted emperor, (M, Fi, Dan), Ref. 2295. Max. 70 cm TL.
Lethrinus erythropterus Valenciennes 1830	Longfin emperor, (M, Fi), Ref. 2295. Max. 50 cm TL. From southwest Sumatra to Timor Sea (Ref. 5978).
Lethrinus genivittatus Valenciennes 1830	Longspine emperor, (M, Br, Fi), Ref. 2295. Max. 25 cm TL. From southwest Sumatra to Timor Sea (Ref. 5978).
Lethrinus harak (Forsskål 1775)	Thumbprint emperor, (M, Fi), Ref. 2295. Max. 50 cm TL.
Lethrinus laticaudis Alleyne & Macleay 1877	Grass emperor, (M, Br, Fi, Sport), Ref. 2295. Max. 56 cm TL.
Lethrinus lentjan (Lacepède 1802)	Pink ear emperor, (M, Fi), Ref. 2295. Max. 50 cm TL. Museum: WAMRL Leth Bali 6/83 (TGT2406). From southwest Sumatra to Bali Strait (Ref. 5978).
Lethrinus microdon Valenciennes 1830	Smalltooth emperor, (M, Fi), Ref. 2295I. Max. 70 cm TL. Museum: LPPL JIF198, from southwest Sumatra to Timor Sea (Ref. 5978).
Lethrinus nebulosus (Forsskål 1775)	Spangled emperor, (M, Fi, Sport), Ref. 2295. Max. 80 cm TL. From Bali Strait to Timor Sea (Ref. 5978).
Lethrinus obsoletus (Forsskål 1775)	Orange-striped emperor, (M, Fi), Ref. 2295. Max. 60 cm TL.
Lethrinus olivaceus Valenciennes 1830	Longface emperor, (M, Fi, Dan), Ref. 2295. Max. 100 cm TL.
Lethrinus ornatus Valenciennes 1830	Ornate emperor, (M, Fi), Ref. 2295. Max. 40 cm TL. Museum: LPPL JIF199, from southwest Sumatra to Timor Sea (Ref. 5978).
Lethrinus reticulatus Valenciennes 1830	Red snout emperor, (M, Fi), Ref. 2295. Max. 40 cm TL.
Lethrinus rubrioperculatus Sato 1978	Spotcheek emperor, (M, Fi), Ref. 2295. Max. 50 cm TL. Museum: WAMRL Leth Bali 10/83, from southwest Sumatra to Timor Sea (Ref. 5978).
Lethrinus semicinctus Valenciennes 1830	Black blotch emperor, (M, Fi), Ref. 2295. Max. 35 cm TL. Museum: CSIRO CA948, from Bali Strait to Timor Sea (Ref. 5978).
Lethrinus variegatus Valenciennes 1830	Slender emperor, (M, Fi), Ref. 2295. Max. 20 cm TL. Museum: CSIRO CA968, from Bali Strait to Timor Sea (Ref. 5978).
Lethrinus xanthochilus Klunzinger 1870	Yellowlip emperor, (M, Fi, Sport), Ref. 2295. Max. 60 cm TL.
Monotaxis grandoculis (Forsskål 1775)	Humpnose big-eye bream, (M, Fi, Dan), Ref. 2295. Max. 60 cm TL. Museum: LPPL JIF200, from southwest Sumatra to Timor Sea (Ref. 5978).

Wattsia mossambica (Smith 1957)	Moz M (R
Lobotidae	**Tripl**
Lobotes surinamensis (Bloch 1790)	Atlan M
Lutjanidae	**Snap**
Aphareus furca (Lacepède 1801)	Sma M
Aphareus rutilans Cuvier 1830	Rust M to
Aprion virescens Valenciennes 1830	Gree SL (T (R
Etelis carbunculus Cuvier 1828	Ruby M Se
Etelis coruscans Valenciennes 1862	Flam
Etelis radiosus Anderson 1981	Scar M Su
Lipocheilus carnolabrum (Chan 1970)	Tang
Lutjanus argentimaculatus (Forsskål 1775)	Man cn (T (R
Lutjanus bengalensis (Bloch 1790)	Beng M Su
Lutjanus biguttatus (Valenciennes 1830)	Two- TL
Lutjanus bitaeniatus (Valenciennes 1830)	Indo M Su
Lutjanus bohar (Forsskål 1775)	Two- 75 (T (F
Lutjanus boutton (Lacepède 1802)	Molu Re Se
Lutjanus carponotatus (Richardson 1842)	Spar M
Lutjanus decussatus (Cuvier 1828)	Chec Al fro in
Lutjanus dodecacanthoides (Bleeker 1854)	Sunt
Lutjanus ehrenbergii (Peters 1869)	Blac Ai

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Lutjanus erythropterus Bloch 1790	Crimson snapper, Bambangan, (M, Fi), Ref. 55. Max. 60 cm TL. Also Ref.: 6567. Museum: LPPL JIF68 (TGT2258). From southwest Sumatra to Timor Sea (Ref. 5978).
Lutjanus fulviflamma (Forsskål 1775)	Blackspot snapper, (M, Fi), Ref. 55. Max. 35 cm TL. Museum: LPPL JIF69, from Bali Strait to Timor Sea (Ref. 5978).
Lutjanus fulvus (Schneider 1801)	Blacktail snapper, (M, Fi, Sport, Dan), Ref. 55. Max. 40 cm TL. Also Ref.: 8631. Museum: LPPL JIF214 (TGT1015). From Bali Strait to Timor Sea (Ref. 5978).
Lutjanus gibbus (Forsskål 1775)	Humpback snapper, (M, Fi, Sport, Dan), Ref. 55. Max. 50 cm TL. Also Ref.: 8631. From Bali Strait to Timor Sea (Ref. 5978).
Lutjanus johnii (Bloch 1792)	John's snapper, (M, Fi, Sport), Ref. 55. Max. 70 cm TL. Also Ref.: 8631. From southwest Sumatra to Timor Sea (Ref. 5978); including Flores.
Lutjanus kasmira (Forsskål 1775)	Common bluestripe snapper, (M, Fi, Sport), Ref. 55. Max. 40 cm TL. Also Ref.: 8631. Known from Bali.
Lutjanus lemniscatus (Valenciennes 1828)	Yellowstreaked snapper, (M, Fi), Ref. 55. Max. 65 cm TL. Museum: LPPL JIF54, from southwest Sumatra to Timor Sea (Ref. 5978).
Lutjanus lunulatus (Park 1797)	Lunartail snapper, (M, Fi), Ref. 55. Max. 35 cm TL. Museum: BPBM 29338, from southwest Sumatra to Bali Strait (Ref. 5978).
Lutjanus lutjanus Bloch 1790	Bigeye snapper, (M, Fi), Ref. 55. Max. 30 cm TL. Also Ref.: 8631. Museum: LPPL JIF55 (TGT2359). From southwest Sumatra to Timor Sea (Ref. 5978); including Flores.
Lutjanus madras (Valenciennes 1831)	Indian snapper, (M, Fi), Ref. 55. Max. 30 cm TL. Museum: LPPL JIF56, from southwest Sumatra to Timor Sea (Ref. 5978).
Lutjanus malabaricus (Bloch & Schneider 1801)	Malabar blood snapper, (M, Fi, Sport), Ref. 55. Max. 100 cm TL. Also Ref.: 6567, 9987. Museum: LPPL JIF57, from southwest Sumatra to Timor Sea (Ref. 5978).
Lutjanus mizenkoi Allen & Talbot 1985	Samoan snapper, (M, Fi), Ref. 55. Max. 30 cm TL.
Lutjanus monostigma (Cuvier 1828)	One-spot snapper, (M, Fi, Dan), Ref. 55. Max. 60 cm TL. Also Ref.: 8631. Museum: LPPL JIF58 (TGT2405). From southwest Sumatra to Timor Sea (Ref. 5978); also Bali.
Lutjanus quinquelineatus (Bloch 1790)	Five-lined snapper, (M, Fi, Sport), Ref. 55. Max. 38 cm TL. Museum: BPBM 29339, from southwest Sumatra to Timor Sea (Ref. 5978).
Lutjanus rivulatus (Cuvier 1828)	Blubberlip snapper, (M, Fi), Ref. 55. Max. 65 cm TL. Also Ref.: 8631. Museum: LPPL JIF60 (TGT2344). From southwest Sumatra to Bali Strait (Ref. 5978); including Flores.
Lutjanus russelli (Bleeker 1849)	Russell's snapper, (M, Fi), Ref. 55. Max. 50 cm TL. Also Ref.: 8631. Museum: LPPL JIF61, from Bali Strait to Timor Sea (Ref. 5978). Also known from Flores.
Lutjanus sebae (Cuvier 1816)	Emperor red snapper, (M, Fi, Sport), Ref. 55. Max. 100 cm TL. Museum: LPPL JIF62, from southwest Sumatra to Timor Sea (Ref. 5978).
Lutjanus semicinctus Quoy & Gaimard 1824	Black-b
Lutjanus timorensis (Quoy & Gaimard 1824)	Timor s Ref.: Sum Flore
Lutjanus vitta (Quoy & Gaimard 1824)	Browns TL. M Timo
Macolor macularis Fowler 1931	Midnigh Also
Macolor niger (Forsskål 1775)	Black a cm S Bali
Paracaesio kusakarii Abe 1960	Saddle- Muse to Ti
Paracaesio sordida Abe & Shinohara 1962	Dirty o
Paracaesio xanthura (Bleeker 1869)	Yellowt GME From
Pinjalo lewisi Randall, Allen, & Anderson 1987	Slende
Pinjalo pinjalo (Bleeker 1850)	Pinjalo, JIF6 5978
Pristipomoides argyrogrammicus (Valenciennes 1832)	Ornate
Pristipomoides auricilla (Jordan, Evermann & Tanaka 1927)	Goldfla
Pristipomoides filamentosus (Valenciennes 1830)	Crimso Muse (Ref.
Pristipomoides flavipinnis Shinohara 1963	Golden
Pristipomoides multidens (Day 1870)	Goldba Muse Timo
Pristipomoides sieboldii (Bleeker 1857)	Lavend SL. I Sea.
Pristipomoides typus Bleeker 1852	Sharpto Ref.: Sum
Pristipomoides zonatus (Valenciennes 1830)	Oblique Max.
Symphorichthys spilurus (Günther 1874)	Sailfin Ref.: Bali
Symphorus nematophorus (Bleeker 1860)	Chinam SL. A (TGT inclu

Table 2. Continuation.
[Tabel 2. Sambungan.]

Malacanthidae	**Tilefishes**
Branchiostegus australiensis Dooley & Kailola 1988	(M), Ref. 9069. Max. 26.6 cm SL. From southwest Sumatra to Bali Strait (Ref. 5978).
Branchiostegus gloerfelti Dooley & Kailola 1988	(M), Ref. 9069. Max. 24 cm SL. From southwest Sumatra to Bali Strait. Museum: WAM P.28304-001 (Holotype).
Hoplolatilus cuniculus Randall & Dooley 1974	Dusky tilefish, (M), Ref. 8631. Max. 12.9 cm SL. Known from Flores.
Hoplolatilus fourmanoiri Smith 1964	Yellow-spotted tilefish, (M), Ref. 8991. Max. 13.7 cm TL.
Hoplolatilus luteus Allen & Kuiter 1989	Yellow tilefish, Yellow-spotted tilefish, (M), Ref. 8989. Max. 10 cm. From Flores (Ref. 8631).
Hoplolatilus marcosi Burgess 1977	Redback sand tilefish, (M), Ref. 9137. Max. 10 cm TL.
Hoplolatilus starcki Randall & Dooley 1974	Stark's tilefish, (M), Ref. 8631. Max. 11.6 cm SL. Also Ref.: 1602. Known from Flores and the Moluccas.
Malacanthus brevirostris Guichenot 1848	Quakerfish, (M), Ref. 5978. Max. 30 cm TL. Also Ref.: 8991. Museum: BMNH uncatalogued: (PJPW2043). ZMA 111.185; RMNH 184; AMS IA.7011; AMS IB.129. From southwest Sumatra to Bali Strait.
Malacanthus latovittatus (Lacepède 1801)	Blue blanquillo, (M), Ref. 5978. Max. 45 cm SL. Also Ref.: 8631, 8991. Museum: LPPL JIF45 (TGT3033). ZMA 111.184; RMNH 16012; USNM 216683 - 4. From Bali Strait to Timor Sea; including Flores.
Menidae	**Moonfish**
Mene maculata (Bloch & Schneider 1801)	Moonfish, (M, Br, Fi), Ref. 5978. Max. 30 cm TL. Museum: LPPL JIF49 (TGT2223). From southwest Sumatra to Timor Sea.
Microdesmidae	**Wormfishes**
Gunnellichthys curiosus Dawson 1968	Curious wormfish, Neon worm-goby, (M), Ref. 2334 Max. 11.5 cm TL. From Flores (Ref. 8631).
Gunnellichthys monostigma Smith 1958	Onespot wormfish, Black-spot worm-goby, (M), Ref. 2334 Max. 11 cm TL. From Bali (Ref. 8631).
Gunnellichthys pleurotaenia Bleeker 1858	Onestripe wormfish, (M), Ref. 1602. Max. 7.4 cm SL. Also Ref.: 8631. Known from Java and Flores.
Nemateleotris decora Randall & Allen 1973	Elegant firefish, (M), Ref. 8631. Max. 7.5 cm TL. Known from Flores.
Nemateleotris magnifica Fowler 1938	Fire goby, (M), Ref. 8631. Max. 9 cm TL. Known from Flores.
Parioglossus nudus Rennis & Hoese 1985	(M), Ref. 1602.
Parioglossus palustris (Herre 1945)	(M, Br), Ref. 1602.
Parioglossus raoi (Herre 1939)	(M, Br), Ref. 1602. Max. 3.1 cm SL.
Ptereleotris evides (Jordan & Hubbs 1925)	Blackfin dartfish, (M), Ref. 528. Max. 12 cm TL. Also Ref.: 8631. Known from Flores.
Ptereleotris grammica Randall & Lubbock 1982	Lined dartfish, (M), Ref. 528. Max. 10 cm.
Ptereleotris hanae (Jordan & Snyder 1901)	Blue hana goby, (M), Ref. 8631. Max. 10 cm SL. Known from Bali.
Ptereleotris heteroptera (Bleeker 1855)	Blacktail goby, (M), Ref. 528. Max. 14 cm TL. Also Ref.: 8631. Known from Flores.
Ptereleotris microlepis (Bleeker 1856)	Blue
Ptereleotris monoptera Randall & Hoese 1985	(M), I Kr
Ptereleotris uroditaenia Randall & Hoese 1985	Flagt
Ptereleotris zebra (Fowler 1938)	Chin Kr
Monodactylidae	**Moo**
Monodactylus argenteus (Linnaeus 1758)	Silve Al
Mugilidae	**Mull**
Crenimugil heterocheilus (Bleeker 1855)	Half SL
Liza alata (Steindachner 1892)	Diam R
Liza parmata (Cantor 1849)	Broa cn
Liza subviridis (Valenciennes 1836)	Gree SL
Liza tade (Forsskål 1775)	Tade
Valamugil cunnesius (Valenciennes 1836)	Long
Valamugil speigleri (Bleeker 1858)	Speig
Mullidae	**Goat**
Mulloidichthys flavolineatus (Lacepède 1801)	Yello M JIF
Mulloidichthys vanicolensis (Valenciennes 1831)	Yello
Parupeneus barberinoides (Bleeker 1852)	Bicol Al 59
Parupeneus barberinus (Lacepède 1801)	Dash cn sc
Parupeneus bifasciatus (Lacepède 1801)	Dout cn (P
Parupeneus chrysopleuron (Temminck & Schlegel 1843)	(M), M Se
Parupeneus ciliatus (Lacepède 1802)	Whit
Parupeneus cyclostomus (Lacepède 1801)	Gold cr (T in
Parupeneus heptacanthus (Lacepède 1801)	Cinn Al (F
Parupeneus indicus (Shaw 1803)	India M

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

	Sumatra to Timor Sea.
Parupeneus macronema (Lacepède 1801)	Long-barbel goatfish, (M), Ref. 5978. Max. 35 cm. Also Ref.: 8631. In range Ref.: 5405. Museum: LPPL JIF83 (TGT2307). From southwest Sumatra to Timor Sea; including Bali.
Parupeneus multifasciatus (Quoy & Gaimard 1824)	Manybar goatfish, (M, Fi), Ref. 8631. Max. 30 cm TL. Known from Flores.
Parupeneus pleurostigma (Bennett 1831)	Sidespot goatfish, (M, Fi, Sport), Ref. 5978. Max. 25 cm SL. Also Ref.: 8631. Museum: LPPL JIF85 (TGT963). From Bali Strait to Timor Sea; including Flores.
Parupeneus rubescens (Lacepède 1801)	Rosy goatfish, (M), Ref. 5978. Max. 42 cm. Museum: LPPL JIF86 (TGT3320). From Bali Strait to Timor Sea.
Parupeneus spilurus (Bleeker 1854)	(M), Ref. 9947. Max. 36 cm TL.
Upeneus asymmetricus Lachner 1954	Asymmetrical goatfish, (M), Ref. 3132. Max. 30 cm TL.
Upeneus bensasi (Temminck & Schlegel 1843)	Bensasi goatfish, (M, Fi), Ref. 5978. Max. 20 cm. Museum: NTM S.10995-003 (TGT2591). From southwest Sumatra to Timor Sea.
Upeneus luzonius Jordan & Seale 1907	Darkbarred goatfish, (M), Ref. 5978. Also Ref.: 8631. Museum: CSIRO CA2057) (conspecific material). From Bali Strait to Timor Sea.
Upeneus moluccensis (Bleeker 1855)	Goldband goldfish, Bidji nangka, (M, Fi), Ref. 2110. Max. 30 cm. Also Ref.: 6567. Museum: LPPL JIF87 (TGT2432). From southwest Sumatra to Timor Sea (Ref. 5978).
Upeneus quadrilineatus Cheng & Wang 1963	(M), Ref. 5978. Max. 17 cm SL. Museum: NTM S.10748-012 (TGT1017). From southwest Sumatra to Timor Sea.
Upeneus sulphureus Cuvier 1829	Sulphur goatfish, (M, Br, Fi), Ref. 5978. Max. 23 cm. Museum: LPPL JIF88. From southwest Sumatra to Timor Sea.
Upeneus sundaicus (Bleeker 1855)	Ochrebanded goatfish, Kunir, (M, Br), Ref. 4899. Max. 22 cm.
Upeneus tragula Richardson 1846	Freckled goatfish, (M, Br, Fi), Ref. 5978. Max. 33 cm TL. Also Ref.: 8631. Museum: LPPL JIF89 (TGT1061). From southwest Sumatra to Bali Strait; including Flores.
Upeneus vittatus (Forsskål 1775)	Yellowstriped goatfish, (M), Ref. 5978. Max. 30 cm. Also Ref.: 8631. Museum: LPPL JIF90. From southwest Sumatra to Timor Sea; including Flores.
Nemipteridae	**Threadfin breams, Whiptail breams**
Nemipterus aurora Russell 1993	Dawn threadfin bream, (M), Ref. 9785. Max. 20 cm SL.
Nemipterus balinensis (Bleeker 1858-9)	Balinese threadfin bream, (M, Fi, En), Ref. 3810. Max. 18 cm SL. Museum: NTM S.10824-002, from southwest Sumatra to Timor Sea (Ref. 5978).
Nemipterus balinensoides (Popta 1918)	Dwarf threadfin bream, (M, Fi), Ref. 3810. Max. 12.5 cm SL. Museum: NTM S.11001-002 (TGT2560) as *Nemipterus* sp.2; NTM S.10733-006 as *Nemipterus* sp. 4. From southwest Sumatra to

	Tin
Nemipterus bathybius Snyder 1911	Yellov Ma (TC (Re
Nemipterus bipunctatus (Ehrenberg 1830)	Delag SL
Nemipterus celebicus (Bleeker 1854)	Celeb SL Tin
Nemipterus furcosus (Valenciennes 1830)	Fork- cm Su
Nemipterus gracilis (Bleeker 1873)	Grace Ma (TC (Re
Nemipterus hexodon (Quoy & Gaimard 1824)	Ornat SL Tin
Nemipterus isacanthus (Bleeker 1873)	Teard SL
Nemipterus japonicus (Bloch 1791)	Japan Ma Ba
Nemipterus marginatus (Valenciennes 1830)	Red f 15 sou
Nemipterus mesoprion (Bleeker 1853)	Mauv cm Su
Nemipterus nematophorus (Bleeker 1853)	Doub cm Sui
Nemipterus nematopus (Bleeker 1851)	Yellov 17. Str
Nemipterus nemurus (Bleeker 1857)	Redsp cm
Nemipterus peronii (Valenciennes 1830)	Notch 26. Fro
Nemipterus tambuloides (Bleeker 1853)	Fiveli cm 00 59
Nemipterus thosaporni Russell 1991	Palefi cm
Nemipterus virgatus (Houttuyn 1782)	Golde SL Su
Nemipterus zysron (Bleeker 1856-57)	Slend Ma (TC
Parascolopsis eriomma	Rosy

Table 2. Continuation.
[Tabel 2. Sambungan.]

(Jordan & Richardson 1909)	25.5 cm SL. Museum: NTM S.10995-001 (TGT2592). From southwest Sumatra to Bali Strait (Ref. 5978).
Parascolopsis inermis (Temminck & Schlegel 1843)	Unarmed dwarf monocle bream, (M, Fi), Ref. 3810. Max. 18 cm SL. Museum: NTM S.10752-005, from Bali Strait to Timor Sea (Ref. 5978).
Parascolopsis qantasi Russell & Gloerfelt-Tarp 1984	Slender dwarf monocle bream, (M, En), Ref. 3810. Max. 10.3 cm SL. Museum: NTM S.10996-001 (TGT2323). From southwest Sumatra to Bali Strait (Ref. 5978).
Parascolopsis tanyactis Russell 1986	Long-rayed dwarf monocle bream, (M, Fi), Ref. 3810. Max. 21 cm SL. Museum: NTM S.10739-002 (TGT1782), AMS I.24278-001 (Ref. 9923). From southwest Sumatra to Timor (Ref. 5978).
Parascolopsis tosensis (Kamohara 1938)	Tosa dwarf monocle bream, (M, Fi), Ref. 3810. Max. 10 cm SL. Museum: NTM S.10760-003, from southwest Sumatra to Timor Sea (Ref. 5978).
Pentapodus bifasciatus (Bleeker 1848)	White-shouldered whiptail, (M, Fi), Ref. 3810. Max. 15 cm SL.
Pentapodus caninus (Cuvier 1830)	Small-toothed whiptail, Gurisi, (M, Fi), Ref. 3810. Max. 18.5 cm SL. Also Ref.: 8631. Museum: NTM S.10660-001, from Bali Strait to Timor Sea (Ref. 5978). Also known from Flores.
Pentapodus emeryii (Richardson 1843)	Double whiptail, (M, Fi), Ref. 3810. Max. 24.5 cm SL. Also Ref.: 8631. Museum: NTMS.10731-004, from Bali Strait to Timor Sea (Ref. 5978).
Pentapodus nagasakiensis (Tanaka 1915)	Japanese whiptail, (M, Fi), Ref. 3810. Max. 15 cm SL. Museum: AMS I.22831-033, from Bali Strait to Timor Sea (Ref. 5978).
Pentapodus porosus (Valenciennes 1830)	Northwest Australian whiptail, (M, Fi), Ref. 3810. Max. 23 cm SL.
Pentapodus setosus (Valenciennes 1830)	Butterfly whiptail, Krisi, (M, Fi), Ref. 3810. Max. 17.5 cm SL. Museum: NTM S.10749-004, from southwest Sumatra to Timor Sea (Ref. 5978).
Pentapodus trivittatus (Bloch 1791)	Three-striped whiptail, Krisi, (M, Fi), Ref. 3810 Max. 28 cm TL. Also Ref.: 8631. Museum: NTM S.10733-020, from Bali Strait to Timor Sea (Ref. 5978).
Scolopsis affinis Peters 1877	Peters' monocle bream, (M, Fi), Ref. 3810. Max. 20 cm SL. Also Ref.: 8631. Museum: NTM S.10763-002, from Bali Strait to Timor Sea (Ref. 5978).
Scolopsis auratus (Park 1797)	Yellowstripe monocle bream, (M, Fi), Ref. 3810 Max. 21 cm SL. Museum: NTM S.10771-001, from southwest Sumatra to Bali Strait (Ref. 5978).
Scolopsis bilineatus (Bloch 1793)	Two-lined monocle bream, Ija puti, (M, Fi), Ref. 3810 Max. 20 cm SL. Also Ref.: 8631. Museum: NTM S.10732-001, from Bali Strait to Timor Sea (Ref. 5978). Also known from Flores.
Scolopsis ciliatus (Lacepède 1802)	Saw-jawed monocle bream, Ija putilo ote, (M, Fi), Ref. 3810 Max. 13.5 cm SL. Also Ref.: 8631. Museum: NTM S.10733-005, from Bali Strait to Timor Sea (Ref. 5978).
Scolopsis lineatus Quoy & Gaimard 1824	Striped monocle bream, Pasir-pasir, (M, Fi), Ref. 3810 Max. 20 cm SL. Museum: NTM S.11002-001, from Bali Strait to Timor Sea (Ref. 5978).

Scolopsis margaritifer (Cuvier 1830)	Pearly Ma S.1 597
Scolopsis monogramma (Kuhl & Van Hasselt 1830)	Mono 381 Tim
Scolopsis taeniopterus (Kuhl & Van Hasselt 1830)	Lattice Ma (TG (Re
Scolopsis temporalis (Cuvier 1830)	Bald-s cm
Scolopsis trilineatus Kner 1868	Three 381 fror
Scolopsis vosmeri (Bloch 1792)	White 381 S.1 Sea
Scolopsis xenochrous Günther 1872	Obliqu Ma anc
Nomeidae	**Driftfi**
Cubiceps kotlyari Agafonova 1988	(M), F
Cubiceps pauciradiatus Günther 1872	Bigeye Ma sou
Psenes arafurensis Günther 1889	Bande Mu sou
Psenes pellucidus Lütken 1880	Bluefi Ma (PJ Stra
Psenes whiteleggii Waite 1894	Shado Mu Fro 441
Opistognathidae	**Jawfi**
Opistognathus castelnaui Bleeker 1871	(M), F S.1 Sea
Pempheridae	**Swee**
Parapriacanthus ransonneti Steindachner 1870	Pigmy Ma S.1 to T
Pempheris moluca Cuvier 1831	(M), F sou
Pempheris oualensis Cuvier 1831	Silver Kno

Pempheris schwenkii Bleeker 1855	Schwenk's sweeper, (M), Ref. 2334. Max. 15 cm TL.
Pempheris vanicolensis Cuvier 1831	Vanikoro sweeper, (M), Ref. 5978 Max. 20 cm TL. Museum: NTM S.10732-005 (PAN5). From Southwest Sumatra to Timor Sea.
Pentacerotidae	**Armorheads**
Histiopterus typus Temminck & Schlegel 1844	Sailfin armourhead, (M, Fi), Ref. 5978. Max. 35 cm SL. Museum: CSIRO CA2257. From southwest Sumatra to Bali Strait.
Percophidae	**Duckbills**
Bembrops curvatura Okada & Suzuki 1952	(M), Ref. 5978. Max. 16 cm SL. Museum: NTM S.10740-004 (TGT1630). From Bali Strait to Timor Sea.
Bembrops filodorsalia Okada & Suzuki 1952	Sharpnosed duckbill, (M), Ref. 5978. Max. 20 cm TL. Museum: AMS I.22808-001. From Bali Strait to Timor Sea. In range Ref.: 3132.
Bembrops philippinus Fowler 1939	(M), Ref. 5978. Museum: NTM S.10998-002 (TGT2512). From Bali Strait to Timor Sea.
Chrionema chlorotaenia McKay 1971	(M), Ref. 5978 Max. 22 cm SL. Museum: NTM S.10760-009 (TGT1727). From Bali Strait to Timor Sea.
Pholidichthyidae	**Convict blenny**
Pholidichthys leucotaenia Bleeker 1856	Convict blenny, (M), Ref. 8631. Max. 15 cm TL. Also Ref.: 6201. Known from Flores. Museum: BPBM 18050.
Pinguipedidae	**Sandperches**
Parapercis alboguttata (Günther 1872)	Blue-nosed grubfish, (M), Ref. 3132. Max. 22 cm TL.
Parapercis clathrata Ogilby 1910	Latticed sandperch, (M), Ref. 8631. Max. 15.3 cm SL. Known from Flores.
Parapercis cylindrica (Bloch 1792)	Cylindrical sandperch, (M), Ref. 2334. Max. 13 cm SL.
Parapercis hexophtalma (Cuvier 1829)	Spotted sandmelt, (M), Ref. 8631. Max. 23 cm TL. Known from Flores.
Parapercis millepunctata (Günther 1860)	Blackdotted sand perch, (M), Ref. 8631. Max. 17 cm SL. Known from Bali.
Parapercis mimaseana (Kamohara 1937)	(M), Ref. 5978. Max. 20 cm SL. Museum: CSIRO CA1441. From southwest Sumatra to Bali Strait.
Parapercis multiplicata Randall 1984	Double-stitch grubfish, (M), Ref. 2334. Max. 12 cm TL.
Parapercis sexfasciata (Temminck & Schlegel 1843)	(M), Ref. 5978. Max. 12 cm TL. Museum: BMNH 1984.1.1.88 (TGT (PJPW) 560). From southwest Sumatra to Bali Strait.
Parapercis snyderi Jordan & Starks 1905	U-mark sandperch, (M), Ref. 2334. Max. 10 cm TL.
Parapercis somaliensis Schultz 1968	Weeping sandsmelt, (M), Ref. 5978. Max. 20 cm TL. Museum: NTM S.10746-004 (TGT1342). From Bali Strait to Timor Sea. This is a new record for southern Indonesia.
Parapercis tetracantha (Lacepède 1802)	White-blotched sandperch, (M), Ref. 8631. Max. 22 cm SL. Known from Flores.
Parapercis xanthozona (Bleeker 1849)	Yellowbar sandperch, Peppered grubfish, (M), Ref. 2334 Max. 23 cm TL. From Bali (Ref. 8631).
Plesiopidae	**Roundheads**
Calloplesiops altivelis (Steindachner 1903)	Comet, (M), Ref. 2334. Max. 16 cm TL. Flores (Ref. 8631).

Polynemidae	**Threac**
Eleutheronema tetradactylum (Shaw 1804)	Fourfin
Eleutheronema tridactylum (Bleeker 1849)	Threefi Sum
Filimanus heptadactyla (Cuvier 1829)	Sevenf
Filimanus hexanema (Cuvier 1829)	Javane Jaka Stra
Filimanus perplexa Feltes 1991	Splend Pad
Filimanus sealei (Jordan & Richardson 1910)	Eightfir
Filimanus xanthonema (Valenciennes 1831)	Yellowt 198 Sum
Polydactylus indicus (Shaw 1804)	Indian
Polydactylus microstoma (Bleeker 1851)	Small- Also Fror Borr
Polydactylus multiradiatus (Günther 1860)	Sevent
Polydactylus nigripinnis Munro 1964	Black-f TL.
Polydactylus plebeius (Broussonet 1782)	Stripec Mus Fror
Polydactylus sexfilis (Cuvier 1831)	Sixfing
Polydactylus sextarius (Bloch & Schneider 1801)	Blacks Max Stra
Polynemus verekeri (Saville-Kent 1889)	Dwarf Kno of a traw Feb
Pomacanthidae	**Angelf**
Apolemichthys griffisi (Carlson & Taylor 1981)	Griffis Pho verif
Apolemichthys trimaculatus (Lacepède 1831)	Threes Also (TG
Centropyge aurantius (Lacepède 1831)	Golden Acc occu trad
Centropyge bicolor (Bloch 1787)	Bicolor Also
Centropyge bispinosus (Günther 1860)	Twosp FL.

Table 2. Continuation.
[Tabel 2. Sambungan.]

Centropyge colini Smith-Vaniz & Randall 1974	Cocos-Keeling angelfish, (M), Ref. Max. 7 cm SL. Museum: BPBM 34195.
Centropyge eibli Klausewitz 1963	Blacktail angelfish, (M), Ref. 4859. Max. 15 cm. Also Ref.: 8631. Known from Bali.
Centropyge flavicauda Fraser-Brunner 1933	Whitetail angelfish, (M), Ref. 4537. Max. 5.7 cm SL. Also Ref.: 8631. Known from Flores.
Centropyge nox (Bleeker 1853)	Midnight angelfish, (M), Ref. 4859. Max. 9 cm TL.
Centropyge tibicen (Cuvier 1831)	Keyhole angelfish, (M), Ref. 4537. Max. 14.9 cm SL.
Centropyge vroliki (Bleeker 1853)	Pearlscale angelfish, (M, Fi), Ref. 1602. Max. 7.5 cm SL. Also Ref.: 8631. Known from Flores.
Chaetodontoplus chrysocephalus Bleeker 1854	Orangeface angelfish, Orange-faced angelfish, (M), Ref. 4858. Max. 22 cm.
Chaetodontoplus duboulayi (Günther 1867)	Scribbled angelfish, (M), Ref. 2334. Max. 28 cm TL.
Chaetodontoplus melanosoma (Bleeker 1853)	Black-velvet angelfish, (M), Ref. 5978. Max. 18 cm TL. Also Ref.: 559, 8631. Museum: NTM S.10744-002 (TGT951). From Bali Strait to Timor Sea.
Chaetodontoplus mesoleucus (Bloch 1787)	Vermiculated angelfish, (M), Ref. 1602. Max. 15.1 cm SL.
Genicanthus lamarck (Lacepède 1802)	Blackstriped angelfish, (M), Ref. 2334. Max. 22 cm TL. Also Ref.: 8631. Known from Flores.
Genicanthus melanospilos (Bleeker 1857)	Spotbreast angelfish, (M), Ref. 1602. Max. 14.9 cm SL. Also Ref.: 8631. Known from Flores.
Paracentropyge multifasciatus (Smith & Radcliffe 1911)	Barred angelfish, (M), Ref. 4859. Max. 9.3 cm SL. Also Ref.: 8631.
Pomacanthus annularis (Bloch 1787)	Bluering angelfish, (M), Ref. 5978. Max. 35 cm TL. Also Ref.: 8631. From southwest Sumatra to Timor Sea.
Pomacanthus imperator (Bloch 1787)	Emperor angelfish, (M), Ref. 5978. Max. 40 cm. Also Ref.: 8631. Museum: LPPL JIF97 (TGT3275). From Bali Strait to Timor Sea.
Pomacanthus navarchus (Cuvier 1831)	Bluegirdled angelfish, (M), Ref. 1602. Max. 30 cm TL. Also Ref.: 8631. Known from Flores.
Pomacanthus semicirculatus (Cuvier 1831)	Semicircle angelfish, (M), Ref. 4859. Max. 29 cm SL. Also Ref.: 8631. Museum: LPPL JIF98, from southwest Sumatra to Timor Sea (Ref. 5978).
Pomacanthus sexstriatus (Cuvier 1831)	Sixbar angelfish, (M), Ref. 4859. Max. 46 cm TL. Museum: LPPL JIF99 (TGT3242). From Bali Strait to Timor Sea (Ref. 5978).
Pomacanthus xanthometopon (Bleeker 1853)	Yellowface angelfish, (M, Fi), Ref. 8631. Max. 32 cm SL. Known from Bali.
Pygoplites diacanthus (Boddaert 1772)	Regal angelfish, (M), Ref. 8631. Max. 20.9 cm SL. Known from Bali and Flores.
Pomacentridae	**Damselfishes**
Abudefduf bengalensis (Bloch 1787)	Bengal sergeant, (M, Br), Ref. 4966. Max. 14 cm SL. Also Ref.: 8631. Known from Jakarta.
Abudefduf lorenzi Hensley & Allen 1977	Black-tail sergeant, (M), Ref. 1602. Max. 15 cm SL. Also Ref.: 8631. Known from Flores.
Abudefduf notatus (Day 1870)	Yellowtail sergeant, (M), Ref. 7247. Max. 14 cm SL.
Abudefduf saxatilis (Linnaeus 1758)	Sergeant major, (M, Fi), Ref. 5978. Max. 21.5 cm TL. Museum: LPPL JIF110 (TGT1576). From Bali Strait to Timor Sea.

Abudefduf septemfasciatus (Cuvier 1830)	Ban A
Abudefduf sexfasciatus (Lacepède 1801)	Scis K
Abudefduf sordidus (Forsskål 1775)	Blac A
Abudefduf vaigiensis (Quoy & Gaimard 1825)	Indo Al
Acanthochromis polyacanthus (Bleeker 1855)	Spin R pe
Amblyglyphidodon aureus (Cuvier 1830)	Golc Al
Amblyglyphidodon curacao (Bloch 1787)	Stag
Amblyglyphidodon leucogaster (Bleeker 1847)	Yellc Ki
Amblyglyphidodon ternatensis (Bleeker 1853)	Tern. Al
Amblypomacentrus breviceps (Schlegel & Müller 1839)	Blac Sl
Amphiprion akallopisos Bleeker 1853	Skur Al
Amphiprion chrysopterus Cuvier 1830	Orar Sl
Amphiprion clarkii (Bennett 1830)	Yello Al
Amphiprion ephippium (Bloch 1790)	Sadc Al
Amphiprion frenatus Brevoort 1856	Toma Al
Amphiprion melanopus Bleeker 1852	Fire Al
Amphiprion ocellaris Cuvier 1830	Clow Al
Amphiprion perideraion Bleeker 1855	Pink
Amphiprion polymnus (Linnaeus 1758)	Sadc
Amphiprion sandaracinos Allen 1972	Yello Kr
Amphiprion sebae Bleeker 1853	Brow
Cheiloprion labiatus (Day 1877)	Big-li Al
Chromis alpha Randall 1988	Yello Kr
Chromis amboinensis (Bleeker 1873)	Amb Kr
Chromis analis (Cuvier 1830)	Yello Al
Chromis atripectoralis Welander & Schultz 1951	Black Al
Chromis atripes Fowler & Bean 1928	Dark Kr

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Chromis caudalis Randall 1988	Blue-axil chromis, (M), Ref. 1602. Ref.: 8631. Known from Flores. Max. 7.5 cm SL. Also in
Chromis cinerascens (Cuvier 1830)	Green chromis, (M), Ref. 7247. Max. 10 cm SL.
Chromis delta Randall 1988	Deep-reef chromis, (M), Ref. 1602. Max. 5 cm SL. Also Ref.: 8631. Known from Flores.
Chromis elerae Fowler & Bean 1928	Twinspot chromis, (M), Ref. 8631. Max. 5.5 cm SL. Known from Flores.
Chromis flavipectoralis Randall 1989	Malayan chromis, (M), Ref. 7247. Max. 5.5 cm SL. Museum: Java Sea, Pulau Seribu, Pulau Putri, BPBM 18569 (Holotype) (Ref.10591).
Chromis fumea (Tanaka 1917)	Smokey chromis, (M), Ref. 3132. Max. 10 cm SL Known from Komodo I. (Allen pers. comm.).
Chromis lepidolepis Bleeker 1877	Scaly chromis, (M), Ref. 8631. Max. 6.5 cm SL. Known from Flores.
Chromis lineata Fowler & Bean 1928	Lined chromis, (M), Ref. 7247. Max. 4 cm SL. Also Ref.: 8631. Known from Flores.
Chromis margaritifer Fowler 1946	Bicolor chromis, (M), Ref. 8631. Max. 6.5 cm SL. Known from Flores.
Chromis nigroanalis Randall 1989	Kenyan chromis, (M), Ref. 10591. Max. 9 cm SL. Ranges east to the western Java Sea. Museum: Pulau Seribu, Pulau Pari Grp, Pulau Tikus, USNM 270852.
Chromis retrofasciata Weber 1913	Black-bar chromis, (M), Ref. 1602. Max. 4 cm SL. Also Ref.: 8631. Known from Flores.
Chromis scotochiloptera Fowler 1918	Philippines chromis, (M), Ref. 7247. Max. 12 cm SL. Also Ref.: 8631, 9137. Known from Flores.
Chromis ternatensis (Bleeker 1856)	Ternate chromis, (M), Ref. 1602. Max. 7.4 cm SL. Known from the Manado area, Sulawesi (Celebes), Maumere Bay, Flores, and Komodo I. (Allen, pers. comm.).
Chromis viridis (Cuvier 1830)	Blue-green damselfish, (M), Ref. 8631. Max. 7 cm SL. Known from Flores.
Chromis weberi Fowler & Bean 1928	Weber's chromis, (M), Ref. 8631. Max. 9.5 cm SL. Known from Flores.
Chromis xanthochira (Bleeker 1851)	Yellow-axil chromis, (M), Ref. 1602. Max. 10 cm SL. Also Ref.: 8631. Known from Flores.
Chromis xanthura (Bleeker 1854)	Paletail chromis, (M), Ref. 8631. Max. 12 cm SL. Known from Flores.
Chrysiptera biocellata (Quoy & Gaimard 1825)	Twinspot damselfish, (M), Ref. 8631. Max. 8 cm SL. Known from Flores.
Chrysiptera bleekeri (Fowler & Bean 1928)	Bleeker's damsel, (M), Ref. 7247. Max. 6.5 cm SL. Also Ref.: 8631. Known from Timor and Flores.
Chrysiptera caeruleolineata (Allen 1973)	Blueline demoiselle, (M), Ref. 8631. Max. 4 cm SL. Known from Flores.
Chrysiptera cyanea (Quoy & Gaimard 1825)	Sapphire devil, (M), Ref. 7247. Max. 6 cm SL.
Chrysiptera glauca (Cuvier 1830)	Grey demoiselle, (M), Ref. 1602. Max. 8 cm SL. Known from the Manado area, Sulawesi (Celebes) and Maumere Bay, Flores (Allen, pers. comm.).
Chrysiptera hemicyanea (Weber 1913)	Azure demoiselle, (M), Ref. 4966. Max. 5 cm SL.
Chrysiptera leucopoma (Lesson 1830)	Surge damselfish, (M), Ref. 8631. Max. 6 cm SL. Known from Flores.
Chrysiptera oxycephala (Bleeker 1877)	Blue- Als
Chrysiptera parasema (Fowler 1918)	Goldt Kn an
Chrysiptera rex (Snyder 1909)	King Als
Chrysiptera rollandi (Whitley 1961)	Rollar Re
Chrysiptera springeri (Allen & Lubbock 1976)	Sprin Als an
Chrysiptera talboti (Allen 1975)	Talbo Als Flo
Chrysiptera unimaculata (Cuvier 1830)	Ones Als
Dascyllus aruanus (Linnaeus 1758)	White Als
Dascyllus carneus Fischer 1885	Clouc Jav
Dascyllus melanurus Bleeker 1854	Black Als
Dascyllus reticulatus (Richardson 1846)	Reticu Als
Dascyllus trimaculatus (Rüppell 1828)	Three Als
Dischistodus chrysopoecilus (Schlegel & Müller 1839)	Lagoo Als
Dischistodus fasciatus (Cuvier 1830)	Band Als
Dischistodus melanotus (Bleeker 1858)	Black
Dischistodus perspicillatus (Cuvier 1830)	White fron
Dischistodus prosopotaenia (Bleeker 1852)	Hone Als
Dischistodus pseudochrysopoecilus (Allen & Robertson 1974)	Mona fron
Hemiglyphidodon plagiometopon (Bleeker 1852)	Lagoo Re
Lepidozygus tapeinosoma (Bleeker 1856)	Fusili Kn Ko cor
Neoglyphidodon bonang (Bleeker 1852)	Ocell
Neoglyphidodon crossi Allen 1991	Cross
Neoglyphidodon melas (Cuvier 1830)	Bowti Kr
Neoglyphidodon nigroris (Cuvier 1830)	Black Als
Neoglyphidodon oxyodon (Bleeker 1858)	Blues Als

Table 2. Continuation.
[Tabel 2. Sambungan.]

Neoglyphidodon thoracotaeniatus (Fowler & Bean 1928)	Barhead damsel, Bar-cheek damsel, (M), Ref. 4966 Max. 8.5 cm SL. From Flores (Ref. 8631).
Neopomacentrus anabatoides (Bleeker 1847)	Silver demoiselle, Brown demoiselle, (M), Ref. 4966 Max. 8 cm SL.
Neopomacentrus azysron (Bleeker 1877)	Yellowtail demoiselle, Yellow-tail demoiselle (M), Ref. 4966 Max. 6 cm SL. Also Ref.: 8631. Known from Flores.
Neopomacentrus cyanomos (Bleeker 1856)	Regal demoiselle, (M), Ref. 8631. Max. 7 cm SL. Known from Bali.
Neopomacentrus filamentosus (Macleay 1882)	Brown demoiselle, (M), Ref. 7247. Max. 6 cm SL.
Neopomacentrus nemurus (Bleeker 1857)	Coral demoiselle, (M), Ref. 7247. Max. 5.5 cm SL. Also Ref.: 8631. Known from Flores.
Neopomacentrus taeniurus (Bleeker 1856)	Freshwater demoiselle, (M, Br, Fr), Ref. 4966. Max. 8.5 cm SL.
Neopomacentrus violascens (Bleeker 1848)	Violet demoiselle, (M), Ref. 1602. Max. 5 cm SL. Also Ref.: 8631. Known from Bali.
Plectroglyphidodon dickii (Liènard 1839)	Blackbar devil, (M), Ref. 7247. Max. 8.5 cm SL. Known from the Manado area, Sulawesi (Celebes), Komodo I., and Maumere Bay, Flores (Allen, pers. comm.).
Plectroglyphidodon johnstonianus Fowler & Ball 1924	Johnston Island damsel, (M), Ref. 8631. Max. 7 cm SL. Known from Flores.
Plectroglyphidodon lacrymatus (Quoy & Gaimard 1825)	Whitespotted devil, (M), Ref. 7247. Max. 8.5 cm SL. Known from the Manado area, Sulawesi (Celebes), Komodo I., and Maumere Bay, Flores (Allen, pers. comm.).
Plectroglyphidodon leucozona (Bleeker 1859)	Singlebar devil, (M), Ref. 7247. Max. 9 cm SL. Known from the Manado area, Sulawesi (Celebes), Komodo I., and Maumere Bay, Flores (Allen, pers. comm.).
Plectroglyphidodon phoenixensis (Schultz 1943)	Phoenix devil, (M), Ref. 7247. Max. 7 cm SL. Known from Komodo I. (Allen pers. comm.).
Pomacentrus adelus Allen 1991	Obscure damsel, (M), Ref. 7247. Max. 6.5 cm SL.
Pomacentrus alexanderae Evermann & Seale 1907	Alexander's damsel, (M), Ref. 4966. Max. 7 cm SL. Also Ref.: 8631. Known from Flores.
Pomacentrus amboinensis Bleeker 1868	Ambon damsel, (M), Ref. 1602. Max. 10.5 cm FL. Also Ref.: 8631. Known from Flores.
Pomacentrus auriventris Allen 1991	Goldbelly damsel, (M), Ref. 7247. Max. 5.5 cm SL. Known from the Manado area, Sulawesi (Celebes), Komodo I., and Maumere Bay, Flores (Allen, pers. comm.).
Pomacentrus azuremaculatus Allen 1991	Bluespotted damsel, (M), Ref. 7247. Max. 8 cm SL.
Pomacentrus bankanensis Bleeker 1853	Speckled damselfish, (M), Ref. 7247. Max. 7 cm SL. Also Ref.: 8631. Known from Flores.
Pomacentrus brachialis Cuvier 1830	Charcoal damsel, (M), Ref. 1602. Max. 8 cm SL.
Pomacentrus burroughi Fowler 1918	Burrough's damsel, (M), Ref. 1602. Max. 6.5 cm SL. Known from the Manado area, Sulawesi (Celebes), Komodo I., and Maumere Bay, Flores (Allen, pers. comm.).
Pomacentrus chrysurus Cuvier 1830	Whitetail damsel, (M), Ref. 8631. Max. 7 cm SL. Known from Bali and Flores.
Pomacentrus coelestis Jordan & Starks 1901	Neon damselfish, (M), Ref. 7247. Max. 7 cm SL. Also Ref.: 8631. Known from Flores.
Pomacentrus cuneatus Allen 1991	Wed
Pomacentrus emarginatus Cuvier 1830	Oute
Pomacentrus grammorhynchus Fowler 1918	Blue
Pomacentrus javanicus Allen 1991	Java
Pomacentrus lepidogenys Fowler & Bean 1928	Scal R
Pomacentrus littoralis Cuvier 1830	Smo
Pomacentrus melanochir Bleeker 1877	Indo Al
Pomacentrus moluccensis Bleeker 1853	Lem Re
Pomacentrus nagasakiensis Tanaka 1917	Naga fro
Pomacentrus nigromanus Weber 1913	Gold
Pomacentrus nigromarginatus Allen 1973	Blacl Al
Pomacentrus pavo (Bloch 1787)	Sapp Kr
Pomacentrus philippinus Evermann & Seale 1907	Philip Kr
Pomacentrus reidi Fowler & Bean 1928	Reid' Re
Pomacentrus simsiang Bleeker 1856	Bluel Re
Pomacentrus smithi Fowler & Bean 1928	Smith Re
Pomacentrus taeniometopon Bleeker 1852	Bracl Kr an
Pomacentrus tripunctatus Cuvier 1830	Three Kr
Pomacentrus vaiuli Jordan & Seale 1906	Ocell Ma Flo
Pomacentrus xanthosternus Allen 1991	Yello SL
Premnas biaculeatus (Bloch 1790)	Spine SL
Pristotis jerdoni (Day 1873)	Gulf Mu Str
Stegastes albifasciatus (Schlegel & Müller 1839)	White Als
Stegastes fasciolatus (Ogilby 1889)	Pacif
Stegastes lividus (Bloch & Schneider 1801)	Blunt
Stegastes nigricans (Lacepède 1802)	Dusk Als

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Stegastes obreptus (Whitley 1948)	Western gregory, (M), Ref. 510. Max. 12 cm SL. Molucca Islands and Seribu Islands, off Java.
Priacanthidae	**Bigeyes or catalufas**
Cookeolus japonicus (Cuvier 1829)	Longfinned bullseye, (M), Ref. 5978 Max. 60 cm TL. Museum: USNM 263762 (TGT1414). From southwest Sumatra to Bali Strait.
Heteropriacanthus cruentatus (Lacepède 1801)	Glasseye, Red big-eye, (M, Fi), Ref. 5978 Max. 34 cm TL. Museum: NTM S.10732-007 (PAN20). From Bali Strait to Timor Sea. Also Ref. 8631. In range Ref.: 2334.
Priacanthus blochii Bleeker 1853	Silver big-eye, (M), Ref. 5403. Max. 23.5 cm SL. Museum: USNM 263758 (TGT2531). Found from southwest Sumatra to Bali Strait (Ref. 5978).
Priacanthus fitchi Starnes 1988	(M), Ref. 5403. Max. 18.5 cm SL. Museum: USNM 263760 (TGT2454). From southwest Sumatra to Timor Sea (Ref. 5978).
Priacanthus hamrur (Forsskål 1775)	Moontail bullseye, (M, Fi), Ref. 5978. Max. 45 cm. Museum: USNM 263761 (TGT2414). From southwest Sumatra to Timor Sea.
Priacanthus macracanthus Cuvier 1829	Red bigeye, (M, Fi), Ref. 5978. Max. 29 cm SL. Museum: USNM 263759 (TGT2557). From southwest Sumatra to Timor Sea.
Priacanthus sagittarius Starnes 1988	(M, Fi), Ref. 5403. Max. 29 cm SL. From southwest Sumatra to Timor Sea (Ref. 5978). Museum: Sumatra, USNM 285042 (Holotype); USNM 263757 (TGT2291).
Priacanthus tayenus Richardson 1846	Purple-spotted bigeye, (M, Fi), Ref. 3414. Max. 25 cm Museum: LPPL JIF207 (TGT2587). SL. Found from southwest Sumatra to Timor Sea (Ref. 5978). Also Ref.: 6567.
Pristigenys meyeri (Günther 1872)	(M), Ref. 5403.Max. 22.5 cm SL. Sulawesi and New Guinea.
Pristigenys niphonia (Cuvier 1829)	Japanese bigeye, (M), Ref. 5978. Max. 27.4 cm SL. Museum: CSIRO B.2174. From southwest Sumatra to Bali Strait.
Pseudochromidae	**Dottybacks**
Congrogadus malayanus (Weber 1909)	(M), Ref. 531. Max. 7.1 cm SL. Known from Aru Islands, Arafura Sea.
Congrogadus subducens (Richardson 1843)	Carpet eel-blenny, (M), Ref. 531. Max. 45 cm TL.
Haliophis aethiopus Winterbottom 1985	(M), Ref. 531. Max. 5 cm SL. Museum: Bali, Sanur, off Alit's Beach Bungalows, BPBM 20920 (Holotype); ROM 38419 (Paratype).
Labracinus cyclophthalmus (Müller & Troschel 1849)	Fire-tail devil, (M), Ref. 8631. Max. 20 cm TL. From Flores.
Pseudochromis bitaeniatus (Fowler 1931)	Double-striped dottyback, (M), Ref. 2334. Max. 7 cm TL. Flores (Ref. 8631).
Pseudochromis cyanotaenia Bleeker 1857	Surge dottyback, (M), Ref. 1602. Max. 4.5 cm SL.
Pseudochromis fuscus Müller & Troschel 1849	Brown dottyback, (M), Ref. 8631. Max. 9 cm. In range Ref.: 2334. Known from Bali and Flores.
Pseudochromis marshallensis (Schultz 1953)	Marshall Is. dottyback, (M), Ref. 8631. Max. 6.5 cm SL. Known from Flores.
Pseudochromis paccagnellae Axelrod 1973	Royal dottyback, (M), Ref. 2334. Max. 7 cm TL. Flores (Ref. 8631).
Pseudochromis polynemus Fowler 1931	Longf Kn
Pseudochromis porphyreus Lubbock & Goldman 1974	Mage
Pseudochromis quinquedentatus McCulloch 1926	Spiny 00
Pseudochromis splendens Fowler 1931	Splen fro
Pseudochromis steenei Gill & Randall 1992	Lyreta on or r
Pseudochromis tapeinosoma Bleeker 1853	(M), F
Pseudoplesiops annae (Weber 1913)	(M), F
Pseudoplesiops knighti Allen 1987	(M), F
Pseudoplesiops multisquamatus Allen 1987	Fine-s Ma
Pseudoplesiops rosae Schultz 1943	(M), F
Pseudoplesiops typus Bleeker 1858	Hidde
Rachycentridae	**Cobia**
Rachycentron canadum (Linnaeus 1766)	Cobia Als Bal 109
Scaridae	**Parro**
Bolbometopon muricatum (Valenciennes 1840)	Green cm
Calotomus carolinus (Valenciennes 1840)	Caroli in A
Calotomus spinidens (Quoy & Gaimard 1824)	Spinyt Mu Sea
Hipposcarus longiceps (Valenciennes 1840)	Pacific SL.
Leptoscarus vaigiensis (Quoy & Gaimard 1824)	Marble Mu (Re
Scarus atropectoralis Schultz 1958	Red p Knc
Scarus bleekeri (De Beaufort 1940)	Bleeke Ref
Scarus bowersi (Snyder 1909)	Bower
Scarus dimidiatus Bleeker 1859	Yellow
Scarus festivus Valenciennes 1840	Festiv
Scarus flavipectoralis Schultz 1958	Yellow Knc
Scarus forsteni (Bleeker 1861)	Forste

Table 2. Continuation.
[Tabel 2. Sambungan.]

Scarus frenatus Lacepède 1802	Bridled parrotfish, (M), Ref. 1602. Max. 47 cm TL.
Scarus ghobban Forsskål 1775	Blue-barred parrotfish, (M, Br, Fi), Ref. 5978. Max. 90 cm. Also Ref.: 8631. From southwest Sumatra to Timor Sea.
Scarus gibbus Rüppell 1828	Heavybeak parrotfish, (M), Ref. 2689. Max. 50 cm SL.
Scarus globiceps Valenciennes 1840	Globehead parrotfish, (M), Ref. 1602. Max. 26 cm SL.
Scarus hypselopterus (Bleeker 1853)	Yellow-tail parrotfish, (M), Ref. 8631. Max. 26 cm SL. Also Ref.: 1602.
Scarus japanensis (Bloch 1789)	Palecheek parrotfish, (M), Ref. 2689. Max. 25 cm SL. Also Ref.: 9137.
Scarus javanicus Bleeker 1854	Java parrotfish, (M), Ref. 1602. Max. 26 cm SL.
Scarus microrhinos Bleeker 1854	Steephead parrotfish, (M, Dan), Ref. 2334. Max. 70 cm TL. Also Ref.: 8631. Known from Flores.
Scarus niger Forsskål 1775	Dusky parrotfish, (M), Ref. 1602. Max. 35 cm TL.
Scarus oviceps Valenciennes 1840	Darkcapped parrotfish, (M), Ref. 1602. Max. 30 cm TL.
Scarus prasiognathos Valenciennes 1840	Singapore parrotfish, (M), Ref. 8631. Max. 50 cm SL. Known from Bali.
Scarus psittacus Forsskål 1775	Common parrotfish, (M), Ref. 1602. Max. 30 cm TL.
Scarus pyrrhurus (Jordan & Seale 1906)	(M), Ref. 2689. Max. 25 cm SL.
Scarus quoyi Valenciennes 1840	Quoy's parrotfish, (M), Ref. 8631. Max. 17 cm SL. Known from Flores.
Scarus rivulatus Valenciennes 1840	Rivulated parrotfish, (M), Ref. 2689. Max. 40 cm SL. Museum: LPPL JIF125, from Bali Strait to Timor Sea (Ref. 5978).
Scarus rubroviolaceus (Bleeker 1847)	Ember parrotfish, (M), Ref. 1602. Max. 70 cm TL.
Scarus schlegeli (Bleeker 1861)	Yellowband parrotfish, (M), Ref. 1602. Max. 40 cm TL.
Scarus sordidus Forsskål 1775	Daisy parrotfish, (M), Ref. 1602. Max. 40 cm TL.
Scarus spinus (Kner 1868)	Greensnout parrotfish, (M), Ref. 1602. Max. 30 cm TL.
Scarus strongylocephalus Bleeker 1854	Indian Ocean steephead parrotfish, (M), Ref. 2334 Max. 50 cm.
Scarus tricolor Bleeker 1847	Tricolour parrotfish, (M), Ref. 8631. Max. 40 cm SL. Known from Bali.
Scarus troschelii Bleeker 1853	Troschel's parrotfish, (M), Ref. 2689. Max. 34.6 cm TL. Known from Seribu Islands.
Scarus viridifurcatus (Smith 1956)	Round-head parrotfish, (M), Ref. 9232. Max. 26 cm SL.
Scatophagidae	**Scats**
Scatophagus argus (Linnaeus 1766)	Spotted scat, (M, Fi), Ref. 1602. Max. 38 cm TL.
Sciaenidae	**Drums or croakers**
Argyrosomus amoyensis (Bleeker 1863)	Amoy croaker, (M, Fi), Ref. 5978. Max. 40 cm SL. Museum: BMNH 1984.1.1.75 (TGT (PJPW) 747. Off Java. In range Ref.: 3490.
Aspericorvina jubata (Bleeker 1855)	Prick Sl
Atrobucca kyushini Sasaki & Kailola 1988	Blac Bc
Atrobucca nibe (Jordan & Thompson 1911)	Blac M Ti O
Austronibea oedogenys Trewavas 1977	Yello
Bahaba polykladiskos (Bleeker 1852)	Spin Bc
Chrysochir aureus (Richardson 1846)	Reev
Dendrophysa russelii (Cuvier 1829)	Goat
Johnius amblycephalus (Bleeker 1855)	Bear M sc
Johnius australis (Günther 1880)	Bottl W
Johnius belangerii (Cuvier 1830)	Bela Mi Fr 70
Johnius borneensis (Bleeker 1851)	Shar Ma so
Johnius carouna (Cuvier 1830)	Caro
Johnius coitor (Hamilton 1822)	Coitc
Johnius heterolepis Bleeker 1873	Larg
Johnius hypostoma (Bleeker 1853)	Smai
Johnius latifrons Sasaki 1992	Broa
Johnius macropterus (Bleeker 1853)	Large Mu St
Johnius macrorhynus (Mohan 1975)	Big-s
Johnius novaeguineae (Nichols 1950)	Pape Ty crc
Johnius pacificus Hardenberg 1941	(M, E
Johnius plagiostoma (Bleeker 1850)	Large
Johnius trachycephalus (Bleeker 1851)	Leaft SL
Johnius weberi Hardenberg 1936	Webe

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

	Sumatera, NMW 39989. Java, ZMH 13892. Bali, AMNH 15008. Lombok, BPBM 30075. Flores, BPBM 32186. Bonarate, RMNH 29818. Sulawesi, AMNH 19877. Borneo, FMNH 22518. Also Ref.: 4787, 8631.
Epinephelus faveatus (Valenciennes 1828)	Barred-chest grouper, (M, Fi), Ref. 5222. Max. 32 cm TL. Also Ref.: 4787. Museum: Bali, BPBM 28953. Lombok, BPBM 29921.
Epinephelus flavocaeruleus (Lacepède 1802)	Blue and yellow grouper, (M, Fi), Ref. 5222. Max. 80 cm TL. Also Ref.: 4787. Museum: Boelveweh, Sabang Island (off Sumatera), RMNH 12064.
Epinephelus fuscoguttatus (Forsskål 1775)	Brown-marbled grouper, (M, Fi, Dan), Ref. 5222 Max. 120 cm. Also Ref.: 2114, 4787. Museum: Sumatera, Padang, NMW 40522; ZMB 17741. Java RMNH 19; RMNH 2160. Batavia (Jakarta), NMW 40521. Sulawesi (Celebes), Janeponto, BPBM 26789. Molucca is., Halmahera, USNM 228042. Irian Jaya, USNM 245356.
Epinephelus heniochus Fowler 1904	Bridled grouper, (M, Fi), Ref. 5222. Max. 35 cm SL. Also Ref.: 4787. Museum: Sumatera (Sumatra), Padang, ANSP 27557 (Holotype, Mentawe Strait), NTM S.10998-066, from southwest Sumatra to Bali Strait (Ref. 5978).
Epinephelus lanceolatus (Bloch 1790)	Giant grouper, (M, Br, Fi, Dan), Ref. 5222. Max. 270 cm. Also Ref.: 4787, 7050. Museum: ZMB 169 (Holotype); ZMUC 71. Sumatra, NMW 40582-83. Java Sea, NMW 40578. Java, RMNH 132 (Holotype of *Serranus geographicus*). Batavia (Jakarta), ANSP 90467.
Epinephelus longispinis (Kner 1864)	Longspine grouper, (M, Fi), Ref. 5222. Max. 55 cm. Also Ref.: 4787. Museum: Lombok, BPBM 29853, 30126. Watubela Group, Uran Is., BPBM 34509. From southwest Sumatra to Timor Sea (Ref. 5978).
Epinephelus macrospilos (Bleeker 1855)	Snubnose grouper, (M, Fi), Ref. 5222. Max. 51 cm TL. Also Ref.: 4787. Museum: BMNH 1880.4.21.14; RMNH 31247; USNM 272427. Molluca Is., Batjan, RMNH 5503 (Holotype of *S. macrospilos*).
Epinephelus maculatus (Bloch 1790)	Highfin grouper, (M, Fi, Dan), Ref. 5222. Max. 60.5 cm TL. Also Ref.: 4787, 8631. Museum: Ambon, USNM 210459. CSIRO CA893, from Bali Strait to Timor Sea (Ref. 5978); including Flores.
Epinephelus malabaricus (Bloch & Schneider 1801)	Malabar grouper, (M, Br, Fi, Sport), Ref. 5222. Max. 234 cm. Also Ref.: 4787. Museum: BMNH 1880.4.21.3; MNHN 7332 (Holotype of *S. crapao*); BPBM 29852, 30025, 30125; ZMH 13950. LPPL JIF34, from southwest Sumatra to Timor Sea (Ref. 5978).
Epinephelus melanostigma Schultz 1953	One-blotch grouper, (M, Fi), Ref. 5222. Max. 33 cm TL. Also Ref.: 4787, 5978. Museum: north of Sumbawa, BPBM 28950.
Epinephelus merra Bloch 1793	Honeycomb grouper, (M, Fi), Ref. 5222. Max. 30 cm SL. Also Ref.: 4787. Museum: RMNH 8138. Timor, MNHN 7381. Banda Is., NMW 40644. Ambon, NMW 40641. Ternate, MNHN 5908. Sulawesi, MNHN 6431. Jawa, Jakarta, ANSP 90498; MNHN 7382. Sumatera, ZMB 7660. Puloweh, Sabang, ZMH 13924.

Epinephelus miliaris (Valenciennes 1830)	Netfin Alsc RMI
Epinephelus morrhua (Valenciennes 1833)	Comet
Epinephelus ongus (Bloch 1790)	White- cm (Hol BMI Kari 300 BPE
Epinephelus polyphekadion (Bleeker 1849)	Camou Max Mus 548 170 Dar BPE
Epinephelus quoyanus (Valenciennes 1830)	Longfi Alsc A.57 Sum Java AMS BPE
Epinephelus retouti Bleeker 1868	Red-ti Bali USN Tim
Epinephelus rivulatus (Valenciennes 1830)	Halfmo Alsc 313 *rhyn* BPE
Epinephelus sexfasciatus (Valenciennes 1828)	Sixbar Alsc Java BPE Pan Is., 597
Epinephelus spilotoceps Schultz 1953	Fours Alsc USN 466
Epinephelus stictus Randall & Allen 1987	Black- In J
Epinephelus undulosus (Quoy & Gaimard 1824)	Wavy- Alsc Sula RMI 546 Pula

Table 2. Continuation.
[Tabel 2. Sambungan.]

Gracila albomarginata (Fowler & Bean 1930)	Masked grouper, (M, Fi), Ref. 5222. Max. 38 cm TL. Also Ref.: 4787, 8631. Museum: USNM 89985 (Holotype, Borneo, Kalimantan, Danawan Is., vicinity of Sibuko Bay). Also known from Flores.
Grammistes sexlineatus (Thunberg 1792)	Goldenstriped soapfish, (M), Ref. 5978. Max. 28 cm. Also Ref.: 8631. Museum: LPPLJIF38 (TGT1048). Known from Bali Strait to Timor Sea.
Holanthias rhodopeplus (Günther 1871)	(M), Ref. 5978. From southwest Sumatra to Bali Strait.
Liopropoma mitratum Lubbock & Randall 1978	Pinstriped basslet, (M), Ref. 6180. Max. 7.2 cm SL. Museum: Ceram, USNM 210037.
Liopropoma susumi (Jordan & Seale 1906)	Meteor perch, (M), Ref. 6180. Max. 7.6 cm SL. Museum: Banda Is., USNM 243032. Sulawesi, Kabaena I., USNM 285947.
Liopropoma swalesi (Fowler & Bean 1930)	(M), Ref. 6180. Museum: Sulawesi, USNM 89983 (Holotype of *Chorististium swalesi*); USNM 93393 (Paratype). Molucca I., Saparua, USNM 209922.
Luzonichthys taeniatus Randall & McCosker 1992	(M), Ref. 8524. Museum: Banda Sea, Lucipara Is., Penyu Group, Kadola I., BPBM 32336 (Holotype). Penyu Group, CAS 62527 and USNM 323627 (Paratypes).
Luzonichthys waitei (Fowler 1931)	Waite's splitfin, (M), Ref. 2334. Max. 7 cm. Also Ref.: 8524. Museum: Widi Is., Dodoro I., BPBM 34218. Molucca Is., Suparua Reef (off Kulor), USNM 210395. Great Banda I., USNM 218812. Flores Sea, Kakabea I., BPBM 32360. Flores, Pulau Besar, CAS 62480. Maumere (off fuel dock),CAS 62496.
Plectranthias japonicus (Steindachner 1884)	Japanese perchlet, (M), Ref. 5978. Max. 15 cm TL. Museum: BPBM 28951 (TGT3149). From Bali Strait to Timor Sea.
Plectranthias longimanus (Weber 1913)	Longfin perchlet, (M), Ref. 1602. Max. 2.8 cm SL.
Plectranthias sagamiensis (Katayama 1963)	(M), Ref. 5978. Max. 6 cm SL. Museum: RUSI 19990 (TGT3126). From Bali Strait to Timor Sea.
Plectranthias wheeleri Randall 1980	(M), Ref. 7300. Museum: Celebes, BPBM 22401 (Holotype).
Plectranthias winniensis (Tyler 1966)	(M), Ref. 7300. Max. 4 cm SL.
Plectropomus areolatus Rüppell 1830	Squaretail coralgrouper, (M, Fi, Dan), Ref. 5222 Max. 60 cm SL.
Plectropomus laevis (Lacepède 1801)	Blacksaddled coralgrouper, (M, Fi, Dan), Ref. 8631 Max. 100 cm SL. Known from Bali.
Plectropomus leopardus (Lacepède 1802)	Leopard coralgrouper, (M, Fi, Sport, Dan), Ref. 5222 Max. 68 cm SL. Known from Bali Strait to Timor Sea (Ref. 5978); including Lombok and Flores. Also Ref.: 2114, 4787, 8631.
Plectropomus maculatus (Bloch 1790)	Spotted coralgrouper, (M, Fi, Aq), Ref. 5222. Max. 100 cm SL. Also Ref.: 4787.
Plectropomus oligacanthus (Bleeker 1854)	Highfin coralgrouper, (M, Fi, Dan), Ref. 5222. Max. 75 cm TL. Also Ref.: 8631. Known from Flores.
Plectropomus pessuliferus Fowler 1904	Roving coralgrouper, (M, Fi, Sport), Ref. 5222. Max. 120 cm TL. Museum: AMS I.24048-001, from southwest Sumatra to Bali Strait (Ref. 5978).
Plectropomus punctatus Quoy & Gaimard 1824	Marbled coralgrouper, (M, Fi), Ref. 5978. Max. 96 cm TL. Museum: BMNH 1984.1.1.18 (TGT (PJPW)818a).

	Frc
Pseudanthias bicolor (Randall 1979)	Bicolc Knc
Pseudanthias bimaculatus (Smith 1955)	Two-s Rel
Pseudanthias cichlops (Bleeker 1853)	(M), F
Pseudanthias cooperi (Regan 1902)	Red-b Rec
Pseudanthias dispar (Herre 1955)	Peach fror
Pseudanthias fasciata (Kamohara 1954)	(M), F (TG nev
Pseudanthias huchtii (Bleeker 1857)	Red-c Alsc Mol
Pseudanthias hypselosoma Bleeker 1878	Stocky Flor
Pseudanthias lori (Lubbock & Randall 1976)	Lori's . 160
Pseudanthias luzonensis (Katayama & Masuda 1983)	Yellow Max Bali
Pseudanthias pleurotaenia (Bleeker 1857)	Squar Alsc
Pseudanthias randalli (Lubbock & Allen 1978)	Randa Alsc
Pseudanthias rubrizonatus (Randall 1983)	Red-b Mus Tim
Pseudanthias smithvanizi (Randall & Lubbock 1981)	Prince
Pseudanthias squamipinnis (Peters 1855)	Sea gc 863 002
Pseudanthias tuka (Herre & Montalban 1927)	Yellow TL.
Pseudanthias ventralis (Randall 1979)	Long-fi
Serranocirrhitus latus Watanabe 1949	Hawkfi Kno
Variola albimarginata Baissac 1952	White- Max RMN Molu S.11 (Ref
Variola louti (Forsskål 1775)	Yellow- Max (TG Also
Siganidae	**Rabbit**
Siganus argenteus (Quoy & Gaimard 1825)	Stream Max

Table 2. Marine and brackishwater fishes of Indonesia .
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

	1984.1.1.95, from southwest Sumatra to Bali Strait (Ref. 5978).
Siganus canaliculatus (Park 1797)	White-spotted spinefoot, (M, Br, Fi, Aq, Dan), Ref. 1419 Max. 25 cm TL. Also Ref.: 8631. Museum: LPPL JIF135, from southwest Sumatra to Timor Sea (Ref. 5978).
Siganus corallinus (Valenciennes 1835)	Blue-spotted spinefoot, (M, Fi, Dan), Ref. 1419. Max. 30 cm TL. Also Ref.: 8631. Museum: LPPL JIF136, from southwest Sumatra to Timor Sea (Ref. 5978).
Siganus doliatus Cuvier 1830	Barred spinefoot, (M, Dan), Ref. 1419. Max. 25 cm TL.
Siganus fuscescens (Houttuyn 1782)	Mottled spinefoot, (M, Fi, Dan), Ref. 1419. Max. 40 cm TL.
Siganus guttatus (Bloch 1787)	Orange-spotted spinefoot, (M, Br, Fi, Dan), Ref. 1419 Max. 45 cm TL. Also Ref.: 8631. Including Irian Jaya. Museum: LPPL JIF137, from Bali Strait to Timor Sea (Ref. 5978).
Siganus javus (Linnaeus 1766)	Streaked spinefoot, (M, Br, Fi, Dan), Ref. 1419 Max. 55 cm TL. Also Ref.: 8631. Known from Bali.
Siganus labyrinthodes (Bleeker 1853)	Labyrinth spinefoot, (M, Dan), Ref. 1419. Max. 25 cm TL. Java and Moluccas.
Siganus lineatus (Valenciennes 1835)	Golden-lined spinefoot, (M, Br, Fi, Dan), Ref. 1419 Max. 45 cm TL.
Siganus puellus (Schlegel 1852)	Masked spinefoot, (M, Fi, Dan), Ref. 1419 Max. 38 cm TL. Also Ref.: 8631. Known from Flores.
Siganus punctatissimus Fowler & Bean 1929	Peppered spinefoot, (M), Ref. 1419. Max. 35 cm TL. Northern Indonesia.
Siganus punctatus (Schneider 1801)	Goldspotted spinefoot, (M, Fi, Dan), Ref. 1419 Max. 45 cm SL. Also Ref.: 8631. Museum: LPPL JIF138, from Bali Strait to Timor Sea (Ref. 5978).
Siganus spinus (Linnaeus 1758)	Little spinefoot, (M, Fi, Dan), Ref. 1419. Max. 23 cm SL. Also Ref.: 8631. Museum: NTM S.11044-001, from Bali Strait to Timor Sea (Ref. 5978).
Siganus vermiculatus (Valenciennes 1835)	Vermiculated spinefoot, (M, Br, Fi, Dan), Ref. 1419 Max. 45 cm TL. Also Ref.: 8631. Known from Bali.
Siganus virgatus (Valenciennes 1835)	Barhead spinefoot, (M, Br, Fi, Dan), Ref. 1419 Max. 33 cm TL. Also Ref.: 8631. Museum: NTM S.1075-004, from southwest Sumatra to Bali Strait (Ref. 5978). Includes one record for western Irian Jaya (Ref. 1419).
Siganus vulpinus (Schlegel & Müller 1845)	Foxface, (M, Fi, Dan), Ref. 1419. Max. 25 cm TL. Also Ref.: 8631. Known from Flores.
Sillaginidae	**Smelt-whitings**
Sillaginopsis panijus (Hamilton 1822)	Flathead sillago, (M, Br, Fi), Ref. 6205. Max. 35 cm . Also Ref.: 7050.
Sillago aeolus Jordan & Evermann 1902	Oriental sillago, (M, Fi), Ref. 6205. Max. 30 cm SL.
Sillago burrus Richardson 1842	Western trumpeter sillago, (M, Br, Fi), Ref. 6205 Max. 36 cm SL. Museum: NTM S.10754-002 (TGT1179). From southwest Sumatra to Timor Sea (Ref. 5978). Also Ref.: 7050.
Sillago chondropus Bleeker 1849	Clubfoot sillago, (M, Br, Fi), Ref. 6205. Max. 35 cm SL.

Sillago macrolepis Bleeker 1859	Large-sc cm SL
Sillago nierstraszi Hardenberg 1941	Rough s
Sillago sihama (Forsskål 1775)	Silver sil Muse Timor In ran
Sparidae	**Porgies**
Acanthopagrus berda (Forsskål 1775)	Picnic se TL. Al
Acanthopagrus bifasciatus (Forsskål 1775)	Twobar FL.
Acanthopagrus latus (Houttuyn 1782)	Yellowfir Also I
Argyrops spinifer (Forsskål 1775)	King sol Muse Timor
Rhabdosargus sarba (Forsskål 1775)	Goldline Max.
Taius tumifrons (Temminck & Schlegel 1843)	Yellowb SL. M south
Sphyraenidae	**Barracu**
Sphyraena barracuda (Walbaum 1792)	Great b 200 c JIF2C 5978
Sphyraena forsteri Cuvier 1829	Bigeye Also south
Sphyraena helleri Jenkins 1901	Heller's
Sphyraena jello Cuvier 1829	Pickhar 150 c
Sphyraena obtusata Cuvier 1829	Obtuse Max. JIF11
Sphyraena putnamiae Jordan & Seale 1905	Sawtoo cm T From
Stromateidae	**Butterf**
Pampus argenteus (Euphrasen 1788)	Silver p Muse south Ref.:
Pampus chinensis (Euphrasen 1788)	Chines Max. south
Symphysanodontidae	
Symphysanodon maunaloae Anderson 1970	Longtai Mus to Ti

Table 2. Continuation.
[Tabel 2. Sambungan.]

Symphysanodon typus Bleeker 1878	Insular shelf beauty, (M, Fi), Ref. 5978. Max. 17 cm SL. Museum: GMBL81-162 (TGT1461). From Bali Strait to Timor Sea.
Terapontidae	**Grunters or tigerperches, thornfishes**
Mesopristes argenteus (Cuvier 1829)	(M, Br, Fr), Ref. 7050. Max. 27.5 cm SL. Sumatra, Java, Sulawesi, and Irian Jaya.
Pelates quadrilineatus (Bloch 1790)	Fourlined terapon, (M, Br, Fi), Ref. 559. Max. 24 cm TL. Museum: NTM S.10733-033 (TGT1282). From Bali Strait to Timor Sea (Ref. 5978), to New Guinea (Ref. 559). Also Ref.: 7050.
Terapon jarbua (Forsskål 1775)	Jarbua terapon, (M, Br, Fr, Fi), Ref. 5978. Max. 33 cm TL. Also Ref.: 7050, 8631. Museum: LPPL JIF40 (TGT2614). From southwest Sumatra to Timor Sea (Ref. 5978).
Terapon puta (Cuvier 1829)	Small-scaled terapon, (M, Br, Fi), Ref. 5978. Max. 16 cm TL. Museum: NTM S.10744-006 (TGT926). From Bali Strait to Timor Sea. Also Ref.: 7050.
Terapon theraps (Cuvier 1829)	Largescaled therapon, (M, Br, Fi), Ref. 5978. Max. 30 cm SL. Also Ref.: 8631. Museum: LPPL JIF39 (TGT2213). Known from southwest Sumatra to Timor Sea; including Flores.
Toxotidae	**Archerfishes**
Toxotes chatareus (Hamilton 1822)	Spotted archerfish, (M, Br, Fr, Fi), Ref. 7294. Max. 40 cm TL. Sumatra, Kalimantan, and Irian Jaya. Also Ref.: 7050.
Trichiuridae	**Cutlassfishes**
Assurger anzac (Alexander 1917)	Razorback scabbardfish, (M), Ref. 6181. Max. 250 cm SL.
Benthodesmus macrophthalmus Parin & Becker 1970	Bigeye frostfish, (M), Ref. 6181. Max. 50 cm SL.
Benthodesmus neglectus Parin 1976	Neglected frostfish, (M), Ref. 6181. Max. 23 cm SL.
Benthodesmus tenuis (Günther 1877)	Slender frostfish, (M), Ref. 6181. Max. 230 cm SL.
Benthodesmus tuckeri Parin & Becker 1970	Tucker's frostfish, (M), Ref. 6181. Max. 77 cm SL. Known from the Molucca Islands and south of Java (Ref. 6181).
Benthodesmus vityazi Parin & Becker 1970	Vityaz' frostfish, (M), Ref. 6181. Max. 77 cm SL.
Eupleurogrammus glossodon (Bleeker 1860)	Longtooth hairtai l, (M, Fi), Ref. 6181 Max. 50 cm TL.
Eupleurogrammus muticus (Gray 1831)	Smallhead hairtail, (Nl, Fi), Ref. 6181 Max. 70 cm TL.
Lepturacanthus savala (Cuvier 1829)	Savalani hairtail, (M. Fi), Ref. 6181 Max. 100 cm SL.
Tentoriceps cristatus (Klunzinger 1884)	Crested hairtail, (M, Fi), Ref. 6181. Max. 90 cm TL. Museum: NTM S.11034-001, from southwest Sumatra to Fimor Sea (Ref. 5978).
Trichiurus auriga Klunzinger 1884	Pearly hairtail, (M), Ref. 6181. Max. 35 cm TL.
Trichiurus lepturus Linnaeus 1758	Largehead hairtail, (N 1, Br, Fi, Sport), Ref. 6181 Max. 150 cm SL. Museum: NTM S. 1 1005-005 (TGT2214). From southwest Sumatra to Timor Sea (Ref, 5978). Also Ref.: 6567.

Trichonotidae	**Sanc**
Trichonotus setiger (Bloch & Schneider 1801)	Spot 23
Tripterygiidae	**Thre**
Helcogramma ellioti (Herre 1944)	(M), 16
Helcogramma hudsoni (Jordan & Seale 1906)	(M),
Helcogramma obtusirostris (Klunzinger 1871)	Hotli
Helcogramma springeri Hansen 1986	(M), (h 21
Helcogramma striata Hansen 1986	(M), M 22
Helcogramma trigloides (Bleeker 1858)	(M),
Helcogramma vulcanum Randall & Clark 1993	(M, E ar C
Uranoscopidae	**Star**
Gnathagnus elongatus (Temminck & Schlegel 1843)	(M), 0C Se
Uranoscopus cognatus Cantor 1849	Two- M to
Uranoscopus kaianus Günther 1880	Kai s Bl sc
Uranoscopus oligolepis Bleeker 1878	(M), (T
Uranoscopus sulphureus Valenciennes 1832	Whit M
Xiphiidae	**Swo**
Xiphias gladius Linnaeus 1758	Swo
Xiphiidae	**Swo**
Xiphias gladius Linnaeus 1758	Swo
Zanclidae	**Moc**
Zanclus cornutus (Linnaeus 1758)	Moo R B
Zoarcidae	**Eelp**
Lycodes agulhensis *Andriashev 1959*	(M), I.: Ti
Gobiesociformes (clingfishes)	
Gobiesocidae	**Clin**
Lepadichthys caritus Briggs 1969	Pale G

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Lepadichthys minor Briggs 1955	(M), Ref. 1602. Known from Moluccas.
Pleuronectiformes (flatfishes)	
Bothidae	**Lefteye flounders**
Arnoglossus aspilos (Bleeker 1851)	Spotless lefteye flounder, (M), Ref. 9824. Max. 19 cm TL.
Arnoglossus dalgleishi (von Bonde 1922)	East coast flounder, (M), Ref. 5978. Max. 18.5 cm TL. Museum: BMNH 1984.1.1.103 (PJPW28). From southwest Sumatra to Bali Strait.
Arnoglossus debilis (Gilbert 1905)	Weak lefteye flounder, (M), Ref. 5978. Max. 17 cm TL. Museum: NTM S.10760-007 (TGT1745). From Bali Strait to Timor Sea.
Arnoglossus elongatus Weber 1913	Long lefteye flounder, (M), Ref. 9824. Max. 11 cm TL. Known from Madura.
Arnoglossus polyspilus (Günther 1880)	Many-spotted lefteye flounder, (M), Ref. 9824. Max. 24 cm TL.
Arnoglossus tapeinosoma (Bleeker 1865)	Large-crested lefteye flounder, (M), Ref. 4900 Max. 13 cm TL. Reported from Sumatra (Padang), Java Sea.
Asterorhombus intermedius (Bleeker 1865)	Intermediate flounder, (M), Ref. 3132. Max. 15 cm TL. Known from the Java Sea (Ref. 1602).
Bothus myriaster (Temminck & Schlegel 1846)	Oval flounder, (M), Ref. 5978. Max. 27 cm TL. Museum: BMNH 1984.1.1.104 (TGT (PJPW)694). From southwest Sumatra to Bali Strait.
Bothus pantherinus (Rüppell 1830)	Leopard flounder, (M, Fi), Ref. 5978. Max. 27.5 cm TL. Museum: NTM S.10733-013 (TGT1100). From Bali Strait to Timor Sea.
Chascanopsetta lugubris Alcock 1894	Pelican flounder, (M, Fi), Ref. 5978. Max. 38 cm SL. Museum: BMNH 1984.1.1.106. From southwest Sumatra to Bali Strait.
Crossorhombus azureus (Alcock 1889)	Blue flounder, (M), Ref. 9824. Max. 18 cm TL. Known from the Aru Islands.
Engyprosopon grandisquama (Temminck & Schlegel 1846)	Largescale flounder, (M, Fi), Ref. 5978. Max. 15 cm. Museum: CSIRO CA3066. From southwest Sumatra to Bali Strait.
Engyprosopon mogkii (Bleeker 1854)	(M), Ref. 9824.Max. 11 cm SL.
Grammatobothus polyophthalmus (Bleeker 1865)	Threespot flounder, (M), Ref. 4900. Max. 21 cm TL.
Kamoharaia megastoma (Kamohara 1936)	Wide-mouthed flounder, (M), Ref. 9824. Max. 22.5 cm TL.
Laeops guentheri Alcock 1890	Günther's flounder, (M), Ref. 5978. Max. 14 cm TL. Museum: NTM S.10751-003 (TGT1674). From Bali Strait to Timor Sea.
Neolaeops microphthalmus (von Bonde 1922)	Crosseyed flounder, (M), Ref. 5978. Max. 21 cm SL. Museum: NTM S.10998-004 (TGT2526). From southwest Sumatra to Bali Strait.
Parabothus kiensis (Tanaka 1918)	(M), Ref. 9824. Max. 20.3 cm SL. Known from southern Indonesia.
Psettina brevirictis (Alcock 1890)	(M), Ref. 4417. Max. 8 cm SL. Known from Celebes (Ref. 9824).
Psettina gigantea Amaoka 1963	Rough-scaled flounder, (M), Ref. 9824. Max. 13 cm SL.
Psettina iijimae (Jordan & Starks 1904)	(M), Ref. 9824. Max. 8.5 cm SL. Known from southern Indonesia.
Psettina profunda (Weber 1913)	(M), F Jav
Citharidae	**Citha**
Brachypleura novaezeelandiae Günther 1862	Yellow Rec
Lepidoblepharon ophthalmolepis Weber 1913	Scale- Knc 979
Cynoglossidae	**Tongu**
Cynoglossus abbreviatus (Gray 1835)	Three Mu sou
Cynoglossus arel (Bloch & Schneider 1801)	Large TL. sou
Cynoglossus bilineatus (Bloch 1787)	Fourli
Cynoglossus borneensis (Bleeker 1858)	(M), F
Cynoglossus cynoglossus (Hamilton 1822)	Benga TL.
Cynoglossus kopsii (Bleeker 1851)	(M), F
Cynoglossus lida (Bleeker 1851)	Rough cm
Cynoglossus lingua Hamilton 1822	Long
Cynoglossus monopus (Bleeker 1849)	(M), F
Cynoglossus puncticeps (Richardson 1846)	Speck cm
Cynoglossus suyeni Fowler 1934	(M), F
Paraplagusia bilineatus (Bloch 1787)	Rock
Paralichthyidae	**Large**
Pseudorhombus argus Weber 1913	Peaco
Pseudorhombus arsius (Hamilton 1822)	Large Ma
Pseudorhombus diplospilus Norman 1926	Four t
Pseudorhombus dupliciocellatus Regan 1905	Ocella Mu Fro
Pseudorhombus elevatus Ogilby 1912	Deep Ma Ref
Pseudorhombus javanicus (Bleeker 1853)	Javan Mu sou wes
Pseudorhombus malayanus Bleeker 1865	Malay Mu sou

Table 2. Continuation.
[Tabel 2: Sambungan.]

Pseudorhombus megalops Fowler 1934	(M), Ref. 2688. Max. 20 cm SL. Museum: Indian Ocean (south coasts of Sumatra, Java, and Lombok), HUMZ 111768 - 69; NTM 10760-006. Bali Strait, NTM S.11022-002. Arafura Sea, CSIRO CA2526.
Pseudorhombus neglectus Bleeker 1865	(M), Ref. 5978. Max. 25 cm SL. Museum: BMNH 1984.1.1.105. From southwest Sumatra to Timor Sea.
Pseudorhombus pentophthalmus Günther 1862	Fivespot flounder, (M, Fi), Ref. 559. Max. 18 cm SL. Known from the Java Sea northwards (Ref. 9774).
Pseudorhombus polyspilos (Bleeker 1853)	(M), Ref. 4900
Pseudorhombus quinquocellatus Weber & de Beaufort 1929	Five-eyed flounder, (M), Ref. 9774. Max. 20 cm SL.
Pseudorhombus triocellatus (Bloch & Schneider 1801)	Three spotted flounders, (M, Fi), Ref. 5978. Max. 15 cm SL. Museum: BMNH 1984.1.1.107 (TGT (PJPW)750). From southwest Sumatra to Bali Strait.
Pleuronectidae	**Righteye flounders**
Nematops grandisquama Weber & de Beaufort 1929	Large-scale righteye flounder, (M), Ref. 9792. Max. 9 cm TL. Known from Bali.
Nematops macrochirus Norman 1931	Long-fin righteye flounder, (M), Ref. 9792. Max. 15 cm TL. Known from Bali Strait.
Poecilopsetta colorata Günther 1880	Coloured righteye flounder, (M), Ref. 5978. Max. 17 cm TL. Museum: NTM S.10760-008 (TGT1746). From Bali Strait to Timor Sea.
Poecilopsetta praelonga Alcock 1894	Alcock's narrow-body righteye flounder, (M), Ref. 5978 Max. 17.5 cm TL. Museum: NTM S.10742-001, WAM P.26208-021. From southwest Sumatra to Timor Sea.
Psammodiscus ocellatus Günther 1862	(M), Ref. 3132. Max. 15 cm TL.
Samaris cristatus Gray 1831	Cockatoo righteye flounder, (M), Ref. 5978. Max. 22 cm TL. Museum: WAM P.26200-007. From Bali Strait to Timor Sea.
Samariscus huysmani Weber 1913	Huysman's righteye flounder, (M), Ref. 5978 Max. 11.5 cm TL. Museum: BMNH 1984.1.1.108 (PJPW27). From southwest Sumatra to Bali Strait.
Samariscus maculatus (Günther 1880)	Spotted righteye flounder, (M), Ref. 9792. Max. 10 cm TL. Known from Kei Islands.
Samariscus sunieri Weber & de Beaufort 1929	Sunier's righteye flounder, (M), Ref. 9792. Max. 13 cm TL. Known from Bali.
Psettodidae	**Psettodids**
Psettodes erumei (Bloch & Schneider 1801)	Indian spiny turbot, (M, Fi), Ref. 5978. Max. 64 cm. Also Ref.: 3415, 9987. Museum: LPPL JIF145. From southwest Sumatra to Timor Sea.
Soleidae	**Soles**
Aesopia cornuta Kaup 1858	Unicorn sole, (M), Ref. 5978. Max. 20 cm SL. Museum: CSIRO CA2097, CSIRO CA1494. From southwest Sumatra to Bali Strait.
Aseraggodes cyaneus (Alcock 1890)	(M), Ref. 5978. Max. 8.3 cm SL. Museum: NTM S.10745-005 (TGT1889). From Bali Strait to Timor Sea.
Dexillus muelleri (Steindachner 1879)	Tufted sole, (M), Ref. 561. Max. 18 cm.

Euryglossa orientalis (Bloch & Schneider 1801)	Orie
Liachirus melanospilus (Bleeker 1854)	(M)
Pardachirus pavoninus (Lacepède 1802)	Pea N S
Solea ovata Richardson 1846	Ova
Synaptura commersoniana (Lacepède 1802)	(M)
Zebrias quagga Kaup 1858	Frin
Zebrias zebra (Bloch & Schneider 1787)	Zeb
Tetraodontiformes (puffers and filefishes)	
Balistidae	**Trig**
Abalistes stellaris (Bloch & Schneider 1801)	Sta T s
Balistapus undulatus (Park 1797)	Ora A F
Balistoides conspicillum (Bloch & Schneider 1801)	Clo N S
Balistoides viridescens (Bloch & Schneider 1801)	Tita A F
Canthidermis maculatus (Bloch 1786)	Spo T (
Melichthys indicus Randall & Klausewitz 1973	Indi E E
Melichthys vidua (Solander 1844)	Pin K
Odonus niger (Rüppell 1836)	Rec A F
Pseudobalistes flavimarginatus (Rüppell 1829)	Yell N S
Pseudobalistes fuscus (Bloch & Schneider 1801)	Yell T s
Rhinecanthus aculeatus (Linnaeus 1758)	Wh N T
Rhinecanthus rectangulus (Bloch & Schneider 1801)	We
Rhinecanthus verrucosus (Linnaeus 1758)	Bla

Table 2. Marine and brackishwater fishes of Indonesia.
[Tabel 2. Ikan-ikan laut dan payau Indonesia.]

Sufflamen bursa (Bloch & Schneider 1801)	Boomerang triggerfish, (M, Thr), Ref. 8631. Max. 25 cm TL. Known from Flores.
Sufflamen chrysopterus (Bloch & Schneider 1801)	Halfmoon triggerfish, (M), Ref. 8631. Max. 22 cm TL. Known from Bali.
Sufflamen fraenatus (Latreille 1804)	Masked triggerfish, (M), Ref. 5978. Max. 50 cm. Museum: LPPL JIF159 (TGT2415). From southwest Sumatra to Timor Sea.
Xanthichthys auromarginatus (Bennett 1832)	Gilded triggerfish, (M), Ref. 8631. Max. 22 cm TL. Known from Flores.
Xanthichthys caeruleolineatus Randall, Matsuura & Zama 1978	Blue-line triggerfish, (M), Ref. 1602. Max. 35 cm TL. Museum: BPBM 29340, from southwest Sumatra to Bali Strait (Ref. 5978).
Diodontidae	**Porcupinefishes**
Chilomycterus reticulatus (Linnaeus 1758)	Spotfin burrfish, (M, Dan), Ref. 5978. Max. 75 cm SL. Also Ref.: 8631. Museum: AMS I.22555-001 (TGT1370). From southwest Sumatra to Timor Sea.
Cyclichthys orbicularis (Bloch 1785)	Birdbeak burrfish, (M, Sport), Ref. 5978. Max. 15 cm SL. Also Ref.: 8631. Museum: AMS I.23670-001 (TGT1509). From Bali Strait to Timor Sea.
Cyclichthys spilostylus (Leis & Randall 1982)	Spotbase burrfish, (M), Ref. 5978. Max. 35 cm SL. Museum: LPPL JIF208 (TGT1656). From southwest Sumatra to Timor Sea. In range Ref.: 4423.
Diodon holocanthus Linnaeus 1758	Long-spine porcupinefish, (M), Ref. 5978 Max. 50 cm TL. Also Ref.: 8631. Museum: LPPL JIF168 (TGT2301). From southwest Sumatra to Timor Sea.
Diodon hystrix Linnaeus 1758	Spot-fin porcupinefish, (M, Dan), Ref. 5978. Max. 91 cm TL. Also Ref.: 8631. Museum: LPPL JIF169 (TGT2290). From southwest Sumatra to Timor Sea.
Diodon liturosus Shaw 1804	Black-blotched porcupinefish, (M), Ref. 8631. Max. 55 cm SL. Known from Flores.
Lophodiodon calori (Bianconi 1854)	Four-bar porcupinefish, (M), Ref. 5978. Max. 30 cm SL. Museum: LPPL JIF170 (TGT3328). From Bali Strait to Timor Sea. Known from Java (Ref. 9680).
Molidae	**Molas**
Mola mola (Linnaeus 1758)	Sunfish, (M, Fi), Ref. 4424. Max. 305 cm TL.
Monacanthidae	**Filefishes**
Acreichthys radiatus (Popta 1900)	Radial leatherjacket, (M), Ref. 559. Max. 7 cm TL.
Acreichthys tomentosus (Linnaeus 1758)	Bristle-tail file-fish, (M), Ref. 5978. Max. 8 cm SL. Also Ref.: 8631. Museum: WAM P.28199-001 (TGT1281). From Bali Strait to Timor Sea.
Aluterus monoceros (Linnaeus 1758)	Unicorn leatherjacket, (M), Ref. 5978. Max. 75 cm TL. Also Ref.: 8631. Museum: LPPL JIF151 (TGT2261). From southwest Sumatra to Timor Sea.
Aluterus scriptus (Osbeck 1765)	Scrawled filefish, (M, Sport, Dan), Ref. 5978. Max. 110 cm. Also Ref.: 8631. Museum: LPPL JIH152 (TGT3252). From southwest Sumatra to Timor Sea.
Amanses scopas (Cuvier 1829)	Broom filefish, (M), Ref. 8631. Max. 20 cm TL. Known from Flores.
Anacanthus barbatus Gray 1830	Bearded leatherjacket, (M), Ref. 5978 Museum: LPPL CSIRO CA1418 (conspecific material). From southwest Sumatra to Bali Strait.
Cantherhines dumerili (Hollard 1854)	Whitespotted filefish, (M), Ref. 583. Max. 35 cm TL.
Cantherhines fronticinctus (Günther 1867)	Spe N s
Cantherhines pardalis (Rüppell 1837)	Hor A E
Chaetodermis penicilligera (Cuvier 1817)	Pric
Monacanthus chinensis (Osbeck 1765)	Far
Oxymonacanthus longirostris (Bloch & Schneider 1801)	Lon
Paraluteres prionurus (Bleeker 1851)	Fals F
Paramonacanthus cryptodon (Bleeker 1855)	(M).
Paramonacanthus japonicus (Tilesius 1810)	(M), 0
Pervagor janthinosoma (Bleeker 1854)	Blac
Pervagor melanocephalus (Bleeker 1853)	Rec F
Pervagor nigrolineatus (Herre 1927)	Blac
Pseudalutarius nasicornis (Temminck & Schlegel 1850)	Rhi S s
Pseudomonacanthus macrurus (Bleeker 1857)	Stra N S
Pseudomonacanthus peroni (Hollard 1854)	Pot- N S
Rudarius minutus Tyler 1970	Min K
Thamnaconus striatus (Kotthaus 1979)	Mar F
Thamnaconus tessellatus (Günther 1880)	(M), C
Ostraciidae	**Box**
Lactoria comuta (Linnaeus 1758)	Lon N T
Lactoria fornasini (Bianconi 1846)	Tho N S
Ostracion cubicus Linnaeus 1758	Yell F E
Ostracion meleagris Shaw & Nodder 1796	Whi S
Ostracion nasus Bloch 1785	Sho F
Ostracion rhinorhynchus	Hor

Table 2. Continuation.
[Tabel 2. Sambungan.]

Bleeker 1852	From southwest Sumatra to Timor Sea.
Ostracion solorensis Bleeker 1853	Reticulate boxfish, (M, Dan), Ref. 1602. Max. 10 cm SL.
Tetrosomus gibbosus (Linnaeus 1758)	Humpback turretfish, (M, Dan), Ref. 5978. Max. 30 cm TL. Museum: LPPL JIF161 (TGT2448). From southwest Sumatra to Timor Sea.
Tetrosomus reipublicae (Ogilby 1913)	Smallspine turretfish, (M, Dan), Ref. 5978 Max. 30 cm TL. Museum: NTM S.10995-004 (TGT2611). From southwest Sumatra to Timor Sea.
Tetraodontidae	**Puffers**
Arothron caeruleopunctatus Matsuura 1994	(M), Ref. 9184. Max. 80 cm TL. From Bali Strait to Timor Sea (Ref. 5978).
Arothron hispidus (Linnaeus 1758)	White-spotted puffer, (M, Br, Dan), Ref. 1602. Max. 45 cm SL. From southwest Sumatra to Timor Sea (Ref. 5978).
Arothron immaculatus (Bloch & Schneider 1801)	Narrow-lined toadfish, (M, Br), Ref. 5170. Max. 22.2 cm SL. Also Ref.: 8631. Museum: LPPL JIF166, from Bali Strait to Timor Sea (Ref. 5978).
Arothron manilensis (de Procè 1822)	Narrow-lined puffer, (M, Br), Ref. 5170. Max. 33 cm TL. Also Ref.: 8631. Museum: CSIRO CA2234, from southwest Sumatra to Timor Sea (Ref. 5978).
Arothron meleagris (Bloch & Schneider 1801)	Guineafowl puffer, (M, Dan), Ref. 1602. Max. 40 cm SL.
Arothron nigropunctatus (Bloch & Schneider 1801)	Blackspotted puffer, (M, Dan), Ref. 8631. Max. 27 cm SL. Known from Flores.
Arothron reticularis (Bloch & Schneider 1801)	Reticulated pufferfish, Reticulated puffer, (M, Br), Ref. 9407. Max. 40 cm SL.
Arothron stellatus (Bloch & Schneider 1801)	Starry toadfish, (M), Ref. 5978. Max. 84 cm SL. Museum: LPPL JIF167 (TGT2268). From southwest Sumatra to Timor Sea.
Canthigaster compressa (de Procè 1822)	Compressed toby, (M, Br), Ref. 5978. Max. 8.7 cm SL. Also Ref.: 8631. Museum: NTM S.10749-005 (TGT1816). From Bali Strait to Timor Sea.
Canthigaster coronata (Vaillant & Sauvage 1875)	Crowned puffer, (M), Ref. 5978. Max. 13.5 cm TL. Museum: NTM S.0747-001 (TGT3312). From Bali Strait to Timor Sea.
Canthigaster epilampra (Jenkins 1903)	Lantern toby, (M), Ref. 8631. Max. 10.9 cm. Known from Bali.
Canthigaster investigatoris (Annandale & Jenkins 1910)	(M), Ref. 5978. Museum: BMNH 1984.1.1.111, 1984.1.1.112. From southwest Sumatra to Bali Strait.
Canthigaster janthinoptera (Bleeker 1855)	Spotted puffer, (M), Ref. 8631. Max. 6.2 cm SL. Known from Bali.
Canthigaster leoparda Lubbock & Allen 1979	Leopard sharpnose puffer, (M), Ref. 1602. Max. 5.6 cm SL.
Canthigaster ocellicincta Allen & Randall 1977	Shy toby, Circle-barred puffer, (M), Ref. 2334 Max. 6.5 cm TL. From Flores (Ref. 8631).
Canthigaster solandri (Richardson 1844)	Spotted sharpnose, (M), Ref. 1602. Max. 11 cm TL. Also Ref.: 8631. Known from Flores.
Canthigaster valentini (Bleeker 1853)	Valentinni's sharpnose puffer, (M, Dan), Ref. 8631 Max. 11 cm TL. Known from Flores.
Chelonodon patoca (Hamilton 1822)	Milkspotted puffer, (M, Br, Fr), Ref. 3131. Max. 38 cm.
Lagocephalus gloveri Abe & Tabeta 1983	(M, Dan), Ref. 5978. Max. 35 cm SL. Museum: NMNZ P.15095 (TGT2117). From southwest Sumatra to Timor Sea.
Lagocephalus inermis (Temminck & Schlegel 1850)	Smoc Mu Su
Lagocephalus lagocephalus (Linnaeus 1758)	Ocea Mu sou
Lagocephalus lunaris (Bloch & Schneider 1801)	Greer Ma Frc
Lagocephalus sceleratus (Gmelin 1789)	Silver TL. sou
Lagocephalus spadiceus (Richardson 1845)	Half-s Mu
Sphoeroides pachygaster (Müller & Troschel 1848)	Blunth Mu. to T
Torquigener brevipinnis (Regan 1903)	(M, Da (TG
Torquigener hicksi Hardy 1983	Hick's Mus Stra
Torquigener hypselogeneion (Bleeker 1852)	Orang
Torquigener parcuspinus Hardy 1983	Yellow TL. sou
Torquigener tuberculiferus (Ogilby 1912)	(M), R Fro
Tylerius spinosissimus (Regan 1908)	Spiny
Triacanthidae	**Triple**
Pseudotriacanthus strigilifer (Cantor 1849)	Long-s Max Fro
Triacanthus biaculeatus (Bloch 1786)	Short-r cm Tim
Triacanthus nieuhofii Bleeker 1852	Silver Mus Sun
Tripodichthys angustifrons (Hollard 1854)	Black-
Tripodichthys blochii (Bleeker 1852)	Long-t TL.
Tripodichthys oxycephalus (Bleeker 1851)	Short-t
Trixiphichthys weberi (Chaudhuri 1910)	Blackti Mus Sum
Triacanthodidae	**Spikef**
Atrophacanthus japonicus (Kamohara 1941)	(M), R Fror
Halimochirurgus alcocki Weber 1913	(M), R

Halimochirurgus centriscoides Alcock 1899	Longsnout spikefish, (M), Ref. 5978. Max. 15 cm TL. Museum: BMNH 1984.1.1.109 (TGT (PJPW) 470. From southwest Sumatra to Bali Strait. Also Ref.: 3132.
Macrorhamphosodes platycheilus Fowler 1934	Trumpetsnout spikefish, (M), Ref. 5978. Max. 13 cm TL. Museum: NTM S.10998-009 (TGT2516). From southwest Sumatra to Bali Strait.
Triacanthodes ethiops Alcock 1894	Shortsnout spikefish, (M), Ref. 5978. Max. 8.5 cm SL. Museum: NTM S.10761-003 (TGT (PJPW) 515). From Bali Strait to Timor Sea. In range Ref. 6660.
Tydemania navigatoris Weber 1913	Fleshy-lipped spikefish, (M), Ref. 6660. Max. 12 cm SL. Museum: BMNH 1984.1.1.110 (TGT (PJPW0 515). Found from southwest Sumatra to Timor Sea.
Triodontidae	**Three-toothed puffer**
Triodon macropterus Lesson 1830	Threetooth puffer, (M), Ref. 5978. Max. 54 cm TL. Museum: CSIRO CA801. From Bali Strait to Timor Sea.

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[a]See Appendix I, p. 284, for numbered (FishBase) references.

Using the NAN-SIS and FiSAT Software to Create a Trawl Survey Database for Western Indonesia[a]

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Abstract

This contribution presents the rationale for and some details on the creation of a database for the results of trawl surveys conducted from 1974 to 1981 by five research vessels (*R/Vs Mutiara 4, Jurong, Dr. Fridtjof Nansen, Bawal Putih 2* and *Lemuru*), using the NAN-SIS software for the catch data, and the FiSAT software for the length-frequency data. These software — both distributed by the Food and Agriculture Organization (FAO) and maintained by their authors-- allow further, detailed analysis of the data base made available herewith, and the readers are encouraged to perform such analyses using the contributions in this volume as examples and/or starting points.

Abstrak

Tulisan ini menyajikan alasan dan beberapa informasi rinci tentang pembentukan suatu data-dasar hasil-hasil survei yang dilaksanakan dari tahun 1974 hingga 1981 oleh lima kapal penelitian (kapal-kapal penelitian Mutiara 4, Jurong, Dr. Fridtjof Nansen, Bawal Putih 2 *dan* Lemuru*) dengan menggunakan perangkat lunak NAN-SIS untuk data hasil tangkapan, dan FiSAT untuk data frekuensi-panjang. Perangkat-perangkat lunak ini - yang disebarluaskan oleh Food and Agriculture Organization (FAO) dan disimpan oleh para penulisnya-memungkinkan analisis yang lebih rinci terhadap data-dasar tersebut sebagaimana disajikan disini, dan selanjutnya mendorong para pembaca untuk melakukan analisis seperti ini dengan menggunakan tulisan kami ini sebagai contoh dan/atau langkah awal.*

Introduction

Large-scale inferences on the structure of demersal fish communities drawn from more than one single survey or a series of surveys performed by the same ship appear to have been exceedingly rare (see Longhurst and Pauly 1987 and contributions in Bianchi 1992). One of the reasons for this, besides simple parochialism, is that an enormous effort is required to encode the results of such surveys (Pauly, this vol.). Indeed, this effort has often stumped the organizers of single surveys (see Box 1 for a historical snippet documenting the encoding problems of the JETINDOFISH survey).

This contribution documents the authors' experience in encoding data from numerous surveys, obtained by five different research vessels over a period of eight years. It also enables replication of the analyses in this volume (Pauly 1993).

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Preliminary Data Encoding

The trawl data of *R/V Jurong*, covering areas 3-7 of the JETINDOFISH survey (Lohmeyer, this vol.) and of *R/V Bawal Putih 2*, covering areas 8 and 9 of the same survey (Martosubroto, this vol.), were made available to this project, through the last author, by Mr. Soewito of the Directorate General of Fisheries (DGF), Jakarta, in the form of a magnetic tape in EBCDIC format (density 1,600 bits/inch), produced on 2 November 1985 by the computer center ("Pusat Komputer") of the Department of Agriculture and in printout form (Fig. 1). The tape was read for a preliminary analysis by McManus (1989), and its contents transferred to diskettes. As both the tape and the diskettes subsequently became infected by a fungus, the data on the printout were re-entered by Ms. Luningning Malumay, from September 1992 to September 1994, into a database for trawl data designed by Vakily (1992), using the DataEase software (DataEase 1988).

The species names presented some difficulties, as expected in trawl surveys involving various taxonomists identifying hundreds of species from poorly known waters. More than 70% of the names, current at the time, have since been revised, and many synonymies resulted. The FishBase system

Box 1. JETINDOFISH data processing prcblem.
[Boks 1. Masalah pemrosesan data JETINDOFISH.]

Modules one and two of the JETINDOFISH project have made several cruises and collected considerable data. It was originally intended that these data would be processed in Rome using a computer program package developed for the FAO Arabian Sea Project.[a] This package, modified to meet JETINDOFISH needs, was done as part of the Indian Ocean Project (IOP). The capability no longer exists in Rome to process the data. The process requires expertise knowledgeable of the program and the type of data being processed.

The events have created a problem in getting the data already collected and recorded on forms intended for the Rome program, processed (400 data sheets have been completed). There are several possible solutions to this problem. The simplest solution of course would be to run the data in Rome using the FAO system and computer equipment. The next possible solution is to obtain the computer program from Rome, find a compatible computer in Indonesia and run the data in Indonesia. The advantages of this approach are the closeness to researchers and simplicity in handling data problems. If a compatible computer system is not available in Indonesia, then the next alternative is to "liberate" the FAO program on to another computer system. This is not possible with all computer systems. The last alternative is to create a new system in Indonesia.

The first alternative has the least cost in both time and money, although it is understood that funds are not available in the South China Sea Fisheries Development and Coordinating Programme (SCSP) for computer expenditure. The last is the most expensive in time and money.

There are very few IBM data systems in Jakarta. To place the FAO program in these systems would require computer expertise familiar with the system and computer time both of which would have to be purchased. The capability to do this was not located. The DGF is now using the ICL computer system at the Bureau of Statistics (BPS). This system will not in anyway accept the FAO programs. The BPS staff, however, indicated they could write the necessary program to process the data provided someone else described the functions. BPS would have to be reimbursed for the cost. The problem with this approach would be the necessary expertise to translate the needs for processing the data into a format needed by the BPS staff.

The United States Agency for International Development (USAID) has an ongoing project to computerize the Ministry of Agriculture data. This project will be installing in September a computer for this purpose. In the meantime the project is using a computer that can liberate the FAO program. The project also has computer expertise that can accomplish this task. This project can immediately adopt the FAO program to a local computer, have the survey data key entered, and begin to process the data. The project will also train DGF personnel in the use of the system and will later transfer the data to the Ministry of Agriculture computer system when it is installed.

The USAID project appears to be the least expensive solution for obtaining a computer system and offers early processing of the existing survey data. This will allow changes to be made in the existing program. It is, however, recommended that any form of telecommunications or other sophisticated computer operation not be used.

The USAID project which is under contract to the Iowa State University will need a request from the DGF to initiate this task. This can be with a telephone call to the individual who is in charge of the USAID project.

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February 1980

[a]Flowers, J.M. 1978. A data processing and basic analysis system for demersal fisheries surveys. Regional Fishery Survey and Development Project, Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates. Field Doc. FI:DP/RAB/71/278/4, 79 p. FAO, Rome, Italy.

was used to update many names and to verify their concordance with known geographic ranges (Froese et al., this vol.). The final dataset was summarized by area-depth combinations and processed as described in McManus (this vol.).

A second dataset was created, based on *Mutiara 4* catch records for the years 1976-1979, by Messrs. M. Badrudin and Suhendro Budihardjo shortly before and during their visit to ICLARM, in May-June 1993. This dataset consisted of catch records from 998 trawl hauls, initially encoded using the Lotus 1-2-3 spreadsheet. The records were then turned into NAN-SIS files for Dr. G. Bianchi (see Bianchi et al., this vol.). This dataset was then expanded to include the survey period November 1974-1976 (522 stations) at IMR (Bergen).

A third dataset documented the *R/V Dr. Fridtjof Nansen* trawl survey conducted in Northwestern Sumatra on 6-30 August 1980 (Aglen et al.1981 and Bianchi, this vol.). This had been encoded using NAN-SIS, a database system developed by staff of the *Dr. Fridtjof Nansen* Project of the Institute of Marine Research, Bergen, Norway, and distributed by FAO (Strφmme 1992). Given our wish to make the result of the surveys documented in this book widely available inside and outside Indonesia (Pauly, this vol.), we decided to use NAN-SIS for storing all catch data.

Further, we opted to use FiSAT (FAO-ICLARM Stock Assessment Tools), a software recently released by FAO (Pauly and Garcia 1994; Gayanilo et al. 1996) to store all length-frequency (L/F) data emanating from the surveys.

Use of NAN-SIS for Catch Data Storage

While now disseminated for use by any group with trawl survey data, NAN-SIS was initially developed to meet the needs of the project which deployed the *R/V Dr. Fridtjof Nansen* (actually the predecessor of the ship currently so named) since 1975, in various parts of the intertropical belt (see Bianchi 1992). The data accumulated were stored in different formats, first as datasheets, then as electronic files for various brands of (micro)computers.

One of the key features of NAN-SIS is its routine for reading files created using various formats (Strφmme 1992). We found this routine particularly helpful, given the various datasets created using other systems. This routine is, however, not well-documented by Strφmme (see Box 2 for further details).

Because only up to 999 stations at the time can be transferred from another file, the database on Western Indonesian trawl data was split into three subsets:

1. the 958 stations of the surveys of *R/V Jurong* (746 stations), *Bawal Putih 2* (121), *Dr. Fridtjof Nansen* (79) and *Lemuru* (12), and coded JI.

2. the 522 stations of *R/V Mutiara 4* covering the period 1974-1976 entered directly in NAN-SIS at IMR, coded MU, and 3. the 998 stations of *R/V Mutiara 4* (covering the period 1976-1979) coded MM.

CATCH DETAILS

HAUL NUMBER : 0001

TOTAL CATCH : 82.60 KG

FAM / GEN / SPECIE	CATCH(KG)	NUMBER	CATCH RATE (KG/HR)	DENSITY (KG/SQ KM)
CLUPEIDAE				
SARDINELLA				
LONGICEPS	68.00	1989.00	45.33	326.90
NOMEIDAE	3.80	21.00	2.53	18.20
SPHYRNIDAE	1.90	1.00	1.26	9.10
CARANGIDAE				
DECAPTERUS				
MACROSOMA	8.90	42.00	5.93	42.70
TOTAL :			55.06	397.11

TOTAL NO OF SPECIES : 005

EFFORT (HRS) : 1.50

AREA TRAWLED (SQ/KM) : 0.208

HAUL NUMBER : 0002

TOTAL CATCH : 40.80 KG

FAM / GEN / SPECIE	CATCH(KG)	NUMBER	CATCH RATE (KG/HR)	DENSITY (KG/SQ KM)
CRABS	5.20	17.00	3.46	17.50
MYCTOPHIDAE	10.60	76.00	7.20	36.40
MACROSOMA	0.80	47.00	0.53	2.70
SCOMBRIDAE				
SCOMBER				
JAPONICUS	1.60	2.00	1.06	5.40
TRICHIURIDAE				
TRICHIURUS				
LEPTURUS	16.70	32.00	11.13	56.40
APOGONIDAE	3.50	120.00	2.33	11.80
POMATOMIDAE	0.50	3.00	0.33	1.60
CARANGIDAE				
DECAPTERUS				

Fig. 1. Facsimile of a typical *R/V Jurong* catch data sheet.
[Gambar 1. Fax tentang suatu bentuk penyajian data hasil tangkapan kapal penelitian Jurong.*]*

Fig. 2 provides the rationale for this split.

Encoding of "fresh" data using NAN-SIS, as opposed to transferring already encoded data, was rather straightforward, the only problem, if any, being the need to update the local "species catalog" (i.e., the list of mnemonics; see Box 2) based on the global catalog of the *Dr. Fridtjof Nansen* Project staff (the global catalog required for global comparative analyses was kindly supplied by Dr. Bianchi).

Use of FiSAT for Encoding and Storing Length-Frequency Data

The FiSAT software, created through the merging of ICLARM's Compleat ELEFAN (Pauly 1987; Gayanilo et al. 1988) with FAO's Length-based Fish Stock Assessment (LFSA) (Sparre 1987), and the addition of complementary routines (Pauly and Sparre 1991) was released only in 1995 after thorough debugging.

However, a beta version of FiSAT was available to us, and was used to encode a large fraction of the length-frequency samples, including their weight and ancillary information, (Table 1) collected during the various surveys documented in this volume.[d]

FiSAT was used for this rather than NAN-SIS, which also can store length-frequency data because the former:

1. has been taught at numerous stock assessment courses in Indonesia and elsewhere;
2. will be widely available in Indonesia and elsewhere, and most importantly;
3. contains numerous routines for analysis of length-frequency datafiles.

Pauly et al. (this vol.) provide numerous examples of application of FiSAT to the L/F database documented here.

[d]The catch and effort data for Bali Straits lemuru of Ghofar and Mathews (this vol.) were also encoded using FiSAT, as a two column file (on Diskette 2 of the database).

Table 1. Example of a length-frequency file with incorporated length-frequency data on *Decapterus macrosoma* collected during surveys by various research trawlers (here: *R/V Bawal Putih 2* and R/V *Dr. Fridtjof Nansen*), from 15 May 1980 to 13 November 1980.
[Tabel 1. Contoh suatu penyajian frekuensi-panjang Decapterus macrosoma *yang dikumpulkan selama survei oleh kapal-kapal penelitan trawl (*Bawal Putih 2 *dan* Dr. Fridtjof Nansen*) dari 15 Mei 1980 hingga 13 November 1980.]*

Midlength[a] (TL, cm)	Date 15/05/80 [b]	15/08/80	17/08/80	19/08/80	19/08/80	13/11/80
7.5						1.00
8.5						2.00
9.5						4.00
10.5	18.00					27.00
11.5	36.00					24.00
12.5	36.00					28.00
13.5	43.00					29.00
14.5	51.00					11.00
15.5	50.00					3.00
16.5	27.00			2.00	1.00	2.00
17.5	3.00			7.00	9.00	5.00
18.5	3.00			5.00	4.00	
19.5	2.00		4.00	1.00	1.00	
20.5	1.00					
21.5	1.00					
22.5	1.00	1.00				
23.5		1.00				
24.5		2.00				
25.5		0.00				
26.5		0.00				
27.5		2.00				
28.5		4.00				
29.5		3.00				
30.5		1.00				
31.5		2.00				
Sum	272.00	16.00	4.00	15.00	15.00	136.00
Weight of sample (g)	7900	3400	NA	700	700	4000

[a] i.e., the midpoint of the length class interval.
[b] Details are provided, in this example, only for the first sample viz: location of station [08° 45.5° South Latitude, 116° 35.0° East Longitude]; Station number: 4; Research Vessel: *Bawal Putih 2*; cod end mesh size: 4 cm; Gear type: Demersal trawl; Bottom depth: 45 meters; Time started trawling: 12:32 hrs; other information. The actual FiSAT file contains similar details on each station with length-frequency data.

However, these applications used only part of the data, and similar contributions can still be extracted from the database through the application of FiSAT (or other software).

Incorporation of Occurrence Records into FishBase

In addition to storing survey catch data into NAN-SIS and L/F data into FiSAT, the project which led to this volume also included strong interaction, at ICLARM, with the FishBase Project. This project is involved in the creation and maintenance of an electronic encyclopedia of fish in the world, available on CD-ROM (Froese and Pauly 1996; Froese et al., this vol.).

The interactions with FishBase were two-way:

1. It was used to check the name and distribution of fish in the database documented here (e.g., McManus, this vol. and Pauly et al., this vol.).

2. It is used as repository of occurrence records of fish sampled during the surveys documented in this volume. This was achieved by selecting, from the NAN-SIS database documented above and from Widodo (1976), occurrence records for all species otherwise known to occur in Indonesia (Froese et al., this vol.), thus documenting the range covered by these surveys, and as far as possible, the range of the fishes in Western Indonesia.

These records were read from NAN-SIS (and from a spreadsheet with Widodo's records) into the "OCCURRENCES" table of FishBase (Froese and Capuli 1996); subsequent information, e.g., on sizes, was then added from the FiSAT files.

Thus, the users of the FishBase 97 will find that it thoroughly covers the fishes of Western Indonesia, for which a special map was created within FishBase.

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Appendix II. Indexes
[Lampiran II. Indeks.]

Author */Name Index

*Excludes authors of species names, e.g., "(Bleeker 1867)".

Geographic Index*

**Excludes occurrence records in species list, p. 222 to 274.

Species Index***

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3. Help develop the capacity of national programs to ensure sustainable development of aquatic resources.

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- Publish and disseminate widely research findings;
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