

The Diversity of Grouper (Epinephelinae) in Ambon Island, Maluku, Indonesia

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Abstract

Located in the heart of world's coral triangle, Maluku seas were estimated to harbor around 1,500 species of fish, which make Maluku seas one of the highest in fish diversity. However, the data to support this claim is not yet available. In this report, we focused our research on the diversity of grouper (family Serranidae, subfamily Epinephelinae) that have the highest economic value and usually exported to various countries around the world. Our preliminary research on diversity of groupers landed at fish market around Ambon Island showed astonishing result. We identified 36 species of groupers that belong to 9 genera. Importantly, two of the species *Epinephelus ergastularius* Whitley 1930 and *Saloptia powelli* Smith 1964 were never reported to be found in Indonesia and can be potentially be declared as a new record. Furthermore, there is one species *Cephalopholis igarashiensis* Katayama 1957 that has been found in North Sulawesi but never reported to be found in Maluku waters. The mitochondrial DNA of the above mentioned species are being sequenced and will be reported in a separated report. Our results will have a great contribution in building a new database on the diversity of fish in Maluku and will provide new information to revise the geographical distribution of groupers.

Keywords: coral fish, fisheries, geographical distribution, management, Serranidae

Introduction

Epinephelinae is Subfamily of Serranidae, a large family of fishes from Order Perciformes that comprises about 450 species in 65 genera. They are recognized as groupers. Fishes belong to this group have considerable high economic value. Groupers are among the most marketable group of tropical marine fish. They have high prices at markets and consequently become the main target in fisheries industry (BEETS and HIXON 1994, MORRIS *et al.* 2000, RANDALL 1987, SLUKA and REICHENBACH 1996). The taste and high market value are some of the reasons that cause this group becoming the most important mariculture commodity in Asia and around the world (CHIU *et al.* 2008, JEFRI *et al.* 2015).

The subfamily Epinephelinae has approximately 159 species in 15 genera (HEEMSTRA and RANDALL 1993, MORRIS *et al.* 2000). The group populates a wide range of habitats and exhibits a wide variety of reproductive and growth strategies (JOHANNES 1978, MORRIS *et al.* 2000, SHAPIRO 1987). Some species have a home range larger than 1.8 ha and can migrate in a distance up to 2 km (SAMOILYS 1987, SAMOILYS *et al.* 1997, UNSWORTH *et al.* 2007). Groupers play key function in structuring coral reef communities due to its role as top predatory fish feeding on fish. A thriving and productive reef community is indicated by a large grouper population. However, the population is intensely exploited (BOHNSACK 1994, CHIAPPONE *et al.* 2000, COSTA *et al.* 2003, UNSWORTH *et al.* 2007). Currently, some species of groupers such as Giant Grouper (*Epinephelus lanceolatus*), Mouse Grouper (*Cromileptes altivelis*) and Brown Marbled Grouper (*Epinephelus fuscoguttatus*) are listed as vulnerable, threatened and near-threatened, respectively, based on the Red Data listed by IUCN (RODRIGUES *et al.* 2010). Some researches have been conducted to explore the biodiversity of groupers around the world. HEEMSTRA *et al.* (2002), for example, describes groupers in Atlantic Sea. The result is quite comprehensive, comprises diagnostic character, size, habitat, biology, fisheries, distribution, remarks and key identification to species level. On the other hand, other researches concerning phylogenetic relationship that are still poorly understood due to the high variety of taxa that must be considered. Information about the relationships among the Serranidae has been equally limited (CRAIG and HASTINGS 2007, JEFRI *et al.* 2015).

Evaluation of genetic diversity and phylogeny using modern molecular biology techniques has enabled comparisons between nucleotide and amino acid sequences of different populations. Studies in fish taxonomy using DNA markers have been developed by for example RODRIGUES *et al.* (2010) that utilized microsatellite markers for the identification of some groupers including *E. lanceolatus*, *C. altivelis* and *E. fuscoguttatus*. Recently, the use of molecular phylogenetic approach has been widely accomplished by the newly developed DNA barcoding method. However, identification of fish species based on morphological trait still play important role and irreplaceable especially when the access to sophisticated molecular biology equipment is limited.

Materials and Methods

This research was conducted from April to November 2016 in Ambon Island, Maluku, Indonesia. Coral reef fish were collected at fish markets around Ambon Island (Fig. 1). Three to five specimens from each species were bought and kept in the cool box filled with ice to maintain the integrity of DNA. To avoid redundancy in sampling, list of species collected were developed following each sampling activity. The sellers were interviewed to collect data

for biogeography distribution. Samples from other islands were separated. Samples were then brought to marine ecology laboratory, at Maritime and Marine Science Center of Excellence, Pattimura University. Each specimen was measured, tagged, then laid on styrofoam. The fins were spread with nail and arranged for photograph. The tissue samples were then collected and stored in 95% ethanol for DNA extraction. The reef fish found were identified to the species level based on ALLEN (2000), KUITER and TONOZUKA (2001), ALLEN *et al.* (2003), KUITER and DEBELIUS (2006) and ALLEN and ERDMANN (2012). Samples were then stored in 4% formalin for long term storage.

Results and Discussion

It is widely known that landings of marine fishes in the markets are not similar but depended on natural abundance, consumer preference, geography, history and ease of catch. Consequently, in areas surrounded by coral reef ecosystems, high diversity of species is harvested with various fishing techniques. Usually fish landed in the fish markets of these areas including snappers (Lutjanidae), surgeonfishes and unicornfishes (Acanthuridae), parrotfishes (Labridae), emperor breams (Lethrinidae) and groupers (Epinephelinae) (GARCIA and ROSENBERG 2010, SALAS *et al.* 2007). Among them, groupers are known to be heavily exploited, because they have the highest market price (CHIAPPONE *et al.* 2000, SADOVY 1994). The consequence of dropping grouper fisheries sometimes devastated for many coastal communities and ecosystems especially for those that depend solely on fisheries.

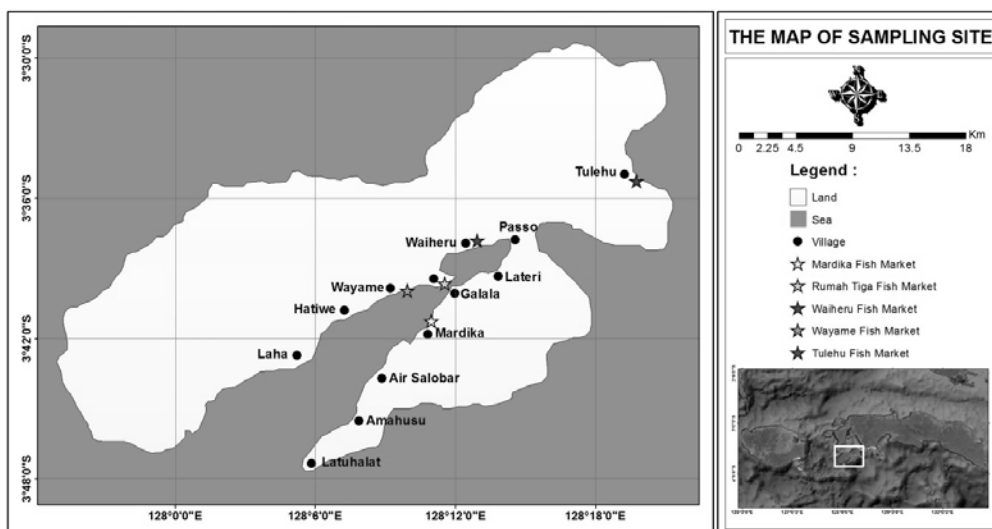


Fig. 1. Map of fish markets in Ambon Island.

Strikingly, despite the reports of decreasing groupers population in Indonesia, we found 36 species of groupers (Epinephelinae) that belong to 9 genera during the study in fish markets of Ambon Island (Table 1). The diversity of groupers found in our study is higher than found in similar studies conducted by RHODES and TUPPER (2007) that found 24 species of groupers in fish markets of Pohnpei, Micronesia and ALCANTARA and YAMBOT (2016) that identified 27 species of groupers from major fish landing sites and markets in the Philippines. Interestingly, two of the species found in Ambon fish markets *Epinephelus ergastularius* Whitley 1930 and *Saloptia powelli* Smith 1964 were never reported to be found in Indonesia and can be potentially declared as a new record. *Epinephelus ergastularius* Whitley 1930 is also known as sevenbar grouper that usually inhabits deep rocky reefs. The original name of this species was recently changed to *Hyphorhodus ergastularius* (CRAIG and HASTINGS 2007, SMITH and CRAIG 2007). This species was previously reported to be found only in Southwest Pacific and the Eastern coast of Australia. *Saloptia powelli* Smith 1964 with common name golden grouper was reported to be found in Pacific Ocean, Western Pacific and French Polynesia. This species has been found in Taiwan, Okinawa (Japan), the Mariana Islands, the Society Islands, American Samoa, Samoa, the Cook Islands, Federated States of Micronesia, French Polynesia, Fiji, Kiribati, New Caledonia, Niue, Palau, Papua New Guinea, the Solomon Islands, South China Sea, Tokelau, Tonga, Tuvalu, the Tuamotu Islands and Vanuatu (HEEMSTRA and RANDALL 1993). This species is widely known to inhabit deep rocky reefs.

Table 1. Groupers found at fish markets in Ambon Island.

No.	Family	Species	No.	Family	Species
1	Serranidae	<i>Aethaloperca rogae</i>	19	Serranidae	<i>Epinephelus coralicola</i>
2	Serranidae	<i>Anyperodon leucogrammicus</i>	20	Serranidae	<i>Epinephelus cyanopodus</i>
3	Serranidae	<i>Cephalopholis argus</i>	21	Serranidae	<i>Epinephelus epistictus</i>
4	Serranidae	<i>Cephalopholis aurantia</i>	22	Serranidae	<i>Epinephelus ergastularius</i>
5	Serranidae	<i>Cephalopholis boenak</i>	23	Serranidae	<i>Epinephelus fasciatus</i>
6	Serranidae	<i>Cephalopholis cyanostigma</i>	24	Serranidae	<i>Epinephelus faveatus</i>
7	Serranidae	<i>Cephalopholis igarashiensis</i>	25	Serranidae	<i>Epinephelus maculatus</i>
8	Serranidae	<i>Cephalopholis miniata</i>	26	Serranidae	<i>Epinephelus melanostigma</i>
9	Serranidae	<i>Cephalopholis nigripinis</i>	27	Serranidae	<i>Epinephelus merra</i>
10	Serranidae	<i>Cephalopholis polleni</i>	28	Serranidae	<i>Epinephelus ongus</i>
11	Serranidae	<i>Cephalopholis sexmaculata</i>	29	Serranidae	<i>Epinephelus quoyanus</i>
12	Serranidae	<i>Cephalopholis spiloparaea</i>	30	Serranidae	<i>Epinephelus spilotoceps</i>
13	Serranidae	<i>Cephalopholis urodeta</i>	31	Serranidae	<i>Gracila albomarginata</i>
14	Serranidae	<i>Epinephelus amblycephalus</i>	32	Serranidae	<i>Liopropoma lemniscatum</i>
15	Serranidae	<i>Epinephelus areolatus</i>	33	Serranidae	<i>Pogonoperca punctata</i>
16	Serranidae	<i>Epinephelus bilobatus</i>	34	Serranidae	<i>Saloptia powelli</i>
17	Serranidae	<i>Epinephelus caeruleopunctatus</i>	35	Serranidae	<i>Variola albimarginata</i>
18	Serranidae	<i>Epinephelus coioides</i>	36	Serranidae	<i>Variola louti</i>

Furthermore, there is one species *Cephalopholis igarashiensis* Katayama 1957 that has been found in North Sulawesi waters but never reported to be found in Maluku waters. Previously, this species has been reported to be found in Tropical Western Pacific, Southern Japan, Taiwan, Guam, Philippines, South China Sea, Samoa and Tahiti (PERISTIWADY *et. al.* 2009). Our results will have a great contribution in building a new database on the diversity of fish in Maluku and will provide new information to revise the geographical distribution of groupers.

Given that fishing pressure is the major driver of population declines in most threatened grouper species, it must be addressed to move towards their recovery. Grouper management has been attempted in various ways, ranging from minimum size limits to protect juvenile fish, recreational bag limits and commercial fishing quotas, gear and seasonal controls, marine protected areas, to limited entry fisheries and slot sizes. Moreover, the establishment of no-take-area (NTA) has been shown to be effective management strategy to increase the population and help maintain and increase the grouper stocks.

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References

- ALCANTARA, S. G. and YAMBOT, A. V. 2016. DNA Barcoding of Commercially Important Grouper Species (Perciformes, Serranidae) in the Philippines. Mitochondrial DNA Part A DNA Mapping, Sequencing, and Analysis, 27(6): 3837–3845.
- ALLEN, G. R. 2000. Marine Fishes of South-East Asia: A Field Guide for Anglers and Divers, 292 pp., Periplus Editions (HK) Ltd., Hong Kong, China.
- ALLEN, G. R., STEENE, R., HUMANN, P. and DELOACH, N. 2003. Reef Fish Identification, Tropical Pacific, 457 pp., New World Publications Inc., Jacksonville, Florida, USA.
- ALLEN, G. R. and ERDMANN, M. V. 2012. Reef Fishes of the East Indies, Vol. I–III, 1260 pp., Tropical Reef Research, Perth, Australia in cooperation with Conservation International, Indonesia Marine Program, Denpasar, Indonesia.
- BEETS, J. and HIXON, M. A. 1994. Distribution, Persistence, and Growth of Groupers (Pisces: Serranidae) on Artificial and Natural Patch Reefs in the Virgin Islands. Bulletin of Marine Science, 55(2–3): 470–483.

- BOHNSACK, J. A. 1994. The Impacts of Fishing on Coral Reefs. In: Proceedings of the Colloquium on Global Aspects of Coral Reefs: Health Hazards and History (Ed. Ginsburg, R. F.), 169–199, RSMAS, University of Miami, Coral Gables, Florida, USA.
- CHIAPPONE, M., SLUKA, R. and SEALEY, K. S. 2000. Groupers (Pisces: Serranidae) in Fished and Protected Areas of the Florida Keys Bahamas and Northern Caribbean. *Marine Ecology Progress Series*, 198: 261–272.
- CHIU, S. T., TSAI, R. T., HSU, J. P., LIU, C. H. and CHENG, W. 2008. Dietary Sodium Alginate Administration to Enhance the Non-Specific Immune Responses, and Disease Resistance of the Juvenile Grouper *Epinephelus fuscoguttatus*. *Aquaculture*, 277: 66–72.
- COSTA, P. A. S., BRAGA, A. D. and DA ROCHA, L. O. F. 2003. Reef Fisheries in Porto Seguro, Eastern Brazilian Coast. *Fisheries Research*, 60: 577–583.
- CRAIG, M. T. and HASTINGS, P. A. 2007. A Molecular Phylogeny of the Groupers of the Subfamily Epinephelinae (Serranidae) with a Revised Classification of the Epinephelini. *Ichthyological Research*, 54: 1–17.
- GARCIA, S. M. and ROSENBERG, A. A. 2010. Food Security and Marine Capture Fisheries: Characteristics, Trends, Drivers and Future Perspectives. *Philosophical Transactions of the Royal Society B*, 365(1554): 2869–2880.
- HEEMSTRA, P. C., ANDERSON, W. D. and LOBEL, P. S. 2002. Serranidae: Groupers (Seabasses, Creolefish, Coney, Hinds, Hamlets, Anthiines, and Soapfishes). In: *The Living Marine Resources of the Western Central Atlantic, Volume 2: Bony Fishes Part 1 (Acipenseridae to Grammatidae)* (Ed. CARPENTER, K. E.), 1308–1369, FAO Species Identification Guide for Fishery Purposes and American Society of Ichthyologists and Herpetologists Special Publication No. 5, FAO, Rome, Italy.
- HEEMSTRA, P. C. and RANDALL, J. E. 1993. FAO Species Catalogue Vol. 16, Groupers of the World (Family Serranidae, Subfamily Epinephelinae), an Annotated and Illustrated Catalogue of the Grouper, Rockcod, Hind, Coral Grouper and Lyretail Species Known to Date, FAO Fisheries Synopsis No. 125, 522 pp., FAO, Rome, Italy.
- JEFRI, E., ZAMANI, N. P., SUBHAN, B. and MADDUPA, H. H. 2015. Molecular Phylogeny Inferred from Mitochondrial DNA of the Grouper *Epinephelus* spp. in Indonesia Collected from Local Fish Market. *Biodiversitas*, 16(2): 254–263.
- JOHANNES, R. E. 1978. Reproductive Strategies of Coastal Marine Fishes in the Tropics. *Environmental Biology of Fishes*, 3(1): 65–84.
- KUITER, R. H. and TONOZUKA, T. 2001. Pictorial Guide to: Indonesian Reef Fishes, Vol. I–III, 893 pp., Zoonetics, Seaford, Australia.
- KUITER, R. H. and DEBELIUS, H. 2006. *World Atlas of Marine Fishes*, 720 pp., IKAN-Unterwasserarchiv, Frankfurt, Germany.
- MORRIS, A. V., ROBERTS, C. M. and HAWKINS, J. P. 2000. The Threatened Status of Groupers (Epinephelinae). *Biodiversity and Conservation Journal*, 9: 919–942.

- PERISTIWADY, T., RAHARDJO, M. F. and SIMANJUNTAK, C. P. H. 2009. A New Record of *Cephalopholis igarashiensis* Katayama, 1957 (Perciformes, Serranidae) from Indonesia. *Jurnal Iktiologi Indonesia*, 9 (1): 25–33.
- RANDALL, J. E. 1987. A Preliminary Synopsis of the Groupers (Perciformes: Serranidae: Epinephelinae) of the Indo-Pacific Region. In: *Tropical Snappers and Groupers: Biology and Fisheries Management* (Eds. POLOVINA, J. J. and RALSTON, S.), 89–189, Westview Press, Boulder, Colorado, USA.
- RHODES, K. L. and TUPPER, M. H. 2007. A Preliminary Market-Based Analysis of the Pohnpei, Micronesia, Grouper (Serranidae; Epinephelinae) Fishery Reveals Unsustainable Fishing Practices. *Coral Reefs*, 26: 335–344.
- RODRIGUES, K. F., SHIGEHARU, S. and CH'NG, C. L. 2010. Microsatellite Markers for the Identification of Commercially Important Groupers *Epinephelus lanceolatus*, *Cromileptes altivelis* and *Epinephelus fuscoguttatus*. *Pertanika Journal of Tropical Agricultural Science*, 34(2): 311–315.
- SADOVY, Y. 1994. Grouper Stocks of the Western Central Atlantic: The Need for Management and Management Needs. *Proceedings of the Gulf and Caribbean Fisheries Institute*, 43: 43–64.
- SALAS, S., CHUENPAGDEE, R., SEIJO, J. C. and CHARLES, A. 2007. Challenges in the Assessment and Management of Small-Scale Fisheries in Latin America and the Caribbean. *Fisheries Research*, 87: 5–16.
- SAMOILYS, M. A. 1987. Aspects of the Behaviour, Movements and Population Density of the Coral Trout, *Plectropomus leopardus* (Lacepede) (Pisces: Serranidae), at Heron Island, Southern Great Barrier Reef, 185 pp., MSc Thesis, Queensland University, Brisbane, Australia.
- SAMOILYS, M. A. 1997. Movement in a Large Predatory Fish: Coral Trout, *Plectropomus leopardus* (Pisces: Serranidae), on Heron Reef, Australia. *Coral Reefs*, 16: 151–158.
- SHAPIRO, D. Y. 1987. Reproduction in Groupers. In: *Tropical Snappers and Groupers: Biology and Fisheries Management* (Eds. POLOVINA, J. J. and RALSTON, S.), 295–327, Westview Press, Boulder, Colorado, USA.
- SLUKA, R. D. and REICHENBACH, N. 1996. Grouper Density and Diversity at Two Sites in the Republic of Maldives. *Atoll Research Bulletin*, 438: 1–16.
- SMITH, W. L. and CRAIG, M. T. 2007. Casting the Percomorph Net Widely: The Importance of Broad Taxonomic Sampling in the Search for the Placement of Serranid and Percid Fishes. *Copeia*, 2007: 35–55.
- UNSWORTH, R. K. F., POWELL, A. HUKOM, F. and SMITH, D. J. 2007. The Ecology of Indo-Pacific Grouper (Serranidae) Species and the Effects of a Small Scale No Take Area on Grouper Assemblage, Abundance and Size Frequency Distribution. *Marine Biology*, 152(2): 243–254.