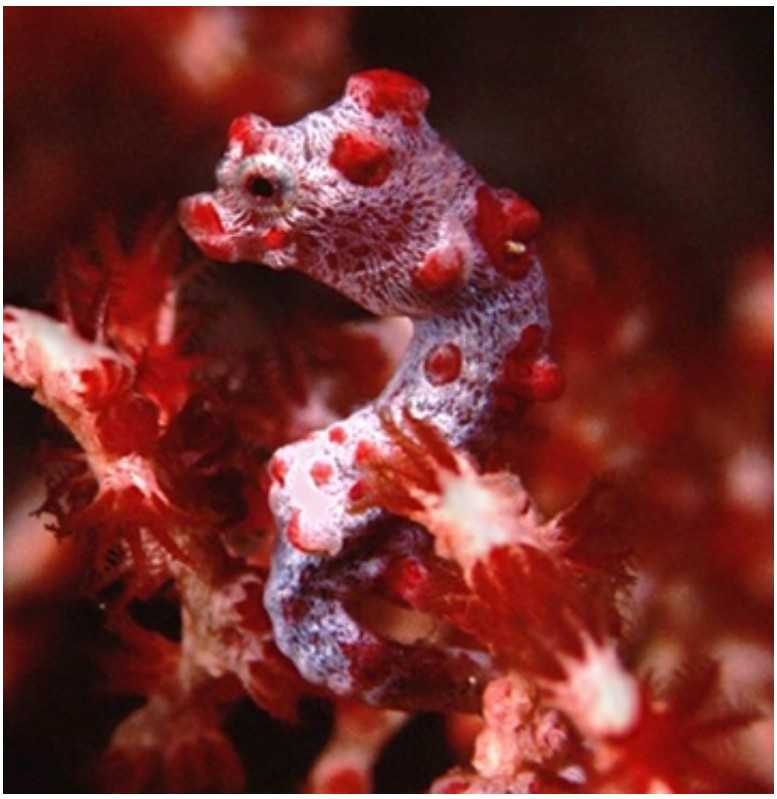
Field Survey Report

SEAHORSES (Genus *Hippocampus*) OF INDONESIA

June 2001



Photograph by Joerg Adam

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Ringkasan:

Penelitian ini mengungkapkan jumlah kuda laut (Teleostei: Syngnathidae: *Hippocampus*) yang terdapat di perairan laut Indonesia sebanyak sembilan jenis. Jenis-jenis tersebut adalah *Hippocampus barbouri, H. bargibanti, H. comes, H. histrix, H. kelloggi, H. kuda, H. spinosissimus, H. trimaculatus* dan *H. sp. nov*. Semua jenis di atas juga dapat ditemukan di perairan Indo-Pasifik lainnya. *H. barbouri, H. comes, H. kelloggi*, dan *H. sp. nov*. merupakan jenis-jenis yang pertama kali ditemukan di Indonesia. Kuda laut dapat ditemukan di seluruh perairan Indonesia meskipun terdapat beberapa perbedaan di antara jenis-jenis tersebut dalam penyebarannya, kedalaman, dan pemilihan habitat.

Ada perbedaan secara morfologi dan genetika antara populasi *H. kuda* dan *H. trimaculatus* yang berlokasi di Paparan Sunda (Sunda Shelf) dengan populasi di luar Paparan Sunda (Indonesia Timur), sehingga dapat disimpulkan bahwa terjadi suatu isolasi sejarah diantara populasi ini.

Berdasarkan wawancara dengan nelayan, pedagang, serta survei lapangan, *Hippocampus spinosissimus* dan *H. trimaculatus* ternyata lebih banyak ditemukan di laut Paparan Sunda, sementara *H. kuda* dan *H. barbouri* lebih banyak di luar daerah Paparan Sunda. Perlu berhati-hati dalam mengambil kesimpulan tentang distribusi jenis-jenis tersebut berdasarkan hasil di atas karena adanya perbedaan penggunaan alat tangkap, perbedaan daerah sampling yang dipakai di wilayah geografis yang berbeda.

Survei lapangan semi kuantitatif (lebih dari 350 orang per jam) dilaksanakan di 39 tempat di 16 wilayah (penyelaman, snorkeling, jalan-jalan di atas karang pada waktu surut). Ditemukan total 165 individu dari lima jenis. 104 diantaranya berasal dari empat lokasi dalam empat hari. Kuda laut sulit ditemukan di perairan, dan kalau pun dapat ditemukan jumlahnya hanya sedikit. Diperlukan survei yang lebih banyak dan giat untuk mengumpulkan jumlah populasi yang akurat. Pada saat ini yang paling penting adalah peringatan untuk menghindarkan penangkapan berlebihan yang dapat menyebabkan berkurangnya populasi kuda laut di habitatnya. Selain itu lingkungannya juga harus dijaga, agar tetap lestari dan tidak menjadi rusak.

Abstract:

A field-based survey of seahorses (Teleostei: Syngnathidae: *Hippocampus*) found in Indonesian waters revealed a total of nine species. These are provisionally assigned to *Hippocampus barbouri, H. bargibanti, H. comes, H. histrix, H. kelloggi, H. kuda, H. spinosissimus, H. trimaculatus* and *H. sp. nov.* All of these species are found in other areas of the Indo-Pacific. *H. barbouri, H. comes, H. kelloggi,* and *H. sp. nov.* are reported from Indonesia for the first time. Seahorses can be found throughout the Archipelago although there is some difference among the species in their distributions, depth and habitat preferences. Populations of *H. kuda* and *H. trimaculatus* found on, versus off, the continental (Sunda) shelf showed some morphological and genetic differences, suggesting that there may be some degree of historical isolation among these populations.

Based primarily on interviews with fishers, plus some in-water surveys and interviews with traders, *Hippocampus spinosissimus* and *H. trimaculatus* appear to be more common on the shelf, whereas *H. kuda* and *H. barbouri* appear to be more common off the shelf. Care should be taken however, when drawing conclusions about the distributions of the species based on these results, because different fishing gears, which inevitably sample different habitats, were prevalent in different geographical regions.

Semi-quantitative in-water surveys (over 350 person-hours) were also carried out, at 39 sites in 16 regions (diving, snorkeling or wading). We found a total of 165 individuals, of five species. 104 of these came from just 4 locations on 4 days. Seahorses appear to be patchy in their distribution, and seem to live at low densities. More rigorous and quantitative surveys are required to obtain more accurate population censuses. In the meantime, we urge caution to prevent over-exploitation, by-catch and habitat destruction from endangering wild populations.

Introduction:

Seahorses (Teleostei: Syngnathidae: *Hippocampus*), are unusual fishes with important ecological and economic value. They are distributed throughout the world in tropical, sub-tropical and some temperate seas (Lourie et al., 1999a). Significant conservation concern regarding the long-term persistence of seahorses in the wild has been raised due to the high level of exploitation of wild populations, particularly in Asia, for traditional medicines (TCM), as aquarium fishes and souvenirs (Vincent, 1996), as well as losses sustained through by-catch and habitat destruction.

Globally over 30 species of seahorses occur, with the highest species richness being found in Southeast Asia/ Australasia (Lourie et al., 1999a). The majority of the species are listed as 'Vulnerable' on the IUCN Red List of Threatened Animals (IUCN, 2000), although accurate estimates of the population status of the different seahorse species in the wild is unavailable. Indeed, there is still debate as to how many species exist (Lourie et al., 1999a) and such lack of knowledge is hampering the development of appropriate conservation, management and legislation plans.

The purpose of this study is to increase our knowledge of the identities of the seahorse species, their distribution, and variation in one of the biologically richest regions in Asia: the Indonesian Archipelago, and thus provide a foundation for conservation efforts in this area. Indonesian texts mention four species: *H. histrix, H. kuda, H. spinosissimus* and *H. trimaculatus* (Saanin, 1984; Dwiponggo, 1970) but initial observations (Lourie et al., 1999a) suggest that this might be an underestimate.

Southeast Asia has had a very complex geological history, with tectonic plate movements, and changes in sea-level over the past 30 million years profoundly influencing the biodiversity of the region (McManus, 1985). Resulting distribution patterns of terrestrial species in this area have already been used for setting conservation priorities (Myers et al., 2000). Marine organisms however, with their high potential for dispersal, are generally believed to exist as widespread taxonomic units, with little local differentiation (Gill, 1999). This concept has led to the (perhaps erroneous) belief that marine species are resistant to extinction (Bruton, 1995). However, recent taxonomic revisions of several marine fish families, such as Pseudochromidae (Gill, 1986) and Blenniidae (Springer & Williams, 1994) suggest that populations may be more isolated from one another than had previously been thought. Hence, an understanding of biogeographic patterns in the sea could be a powerful marine conservation tool.

Seahorses have a low reproductive capacity, internal brooding of the young, sedentary adult life style and many species are monogamous with small and fixed home-ranges (Vincent, 1990). They are thus hypothesised to form small, regionally restricted taxonomic units. If populations are significantly isolated, this may mean that

they are even more vulnerable to current levels of exploitation, and an understanding of their distributions is even more important for conservation management.

To date, the only taxonomic work specifically on seahorses in Southeast Asia is focused on Vietnam (Lourie et al., 1999b). This used morphological and genetic (mitochondrial cytochrome *b* sequence data) to separate the species. Results from the present study (and comparisons to previous work) will be used to test the hypothesis of small taxonomic units related to the underlying geological history of the region, and provide baseline data regarding seahorse species and their distributions.

Objectives:

The specific aims of this research included the following:

- To determine which species of seahorse occur throughout the Indonesian Archipelago
- To clarify their taxonomy, including describing new species
- To document their habitat and distribution
- To assess the genetic connectivity, and biogeographic breaks, among their populations
- To disseminate information on seahorse identification, distribution patterns, and the importance of biogeography for conservation
- To make contacts and form collaborations with biologists and conservation NGOs in Indonesia

This research forms part of a larger study of the taxonomy and biogeography of Indo-Pacific seahorses. Initial results are presented here. The genetic analysis, morphological analysis and new species description will be done on my return to Canada and these results will be presented at a later date.

Implementation:

Indonesia is an archipelago of over 17,000 islands (Tomascik, et al., 1997) so it would be impossible to survey all of them within a few month (or even many year) research project. The approach we adopted in this study involved firstly, extensive consultation with local NGOs, researchers, fisheries officers, fishers and villagers throughout Indonesia to determine areas known to harbour seahorses. Secondly I, or Indonesian counterparts, made visits to these sites (where practical) to obtain specimens and further information from local fishers. We undertook semi-quantitative in-water surveys (wading, or using snorkel or diving equipment) in many areas to

obtain information about seahorse habitats, and to supplement interviews with fishers. We only kept specimens that were already dead (either caught for the trade, kept by local people or caught accidentally in nets). The majority of these will be deposited in the Museum Zoologicum Bogoriense, Cibinong, at the end of this study for future use by Indonesian and international scientists. When live specimens were found, we took morphometric measurements *in situ* (following the protocol of Lourie et al., (1999b) as far as practical) and photographs. We also took a small clip from the dorsal fin for later genetic analysis of their population structure and connectivity among populations. Initial trials suggest that fin clipping seahorses has no detectable long term negative impact on them (*pers. obs*.).

We gathered information from over 50 sites, in 16 regions across Indonesia in an attempt to achieve representative coverage of the archipelago (map 1). Details of the sites where seahorses were found, and the methods used to determine the presence of seahorses, are given in the results section (table 3). Our approaches differed among sites depending on the local conditions, the fishing techniques that occurred in the area, and the time and personnel available. This inconsistency represents a potential source of bias in the data. A brief discussion of the different methods of obtaining information for this study is presented in table 1. Where in-water surveys were done, habitat information is also given in table 3. GPS locations are given for in-water surveys, and rough grid references are given for specimens obtained from fishers where we could be reasonably confident of their origin.

Some specimens deposited in museums (USNM, ZMA, BMNH, MNHN (Levinton et al. (1985)) and specimens or photographs sent to me for identification have also contributed further information and are included in the results.

Map 1: Indonesian Archipelago and place names mentioned in the text

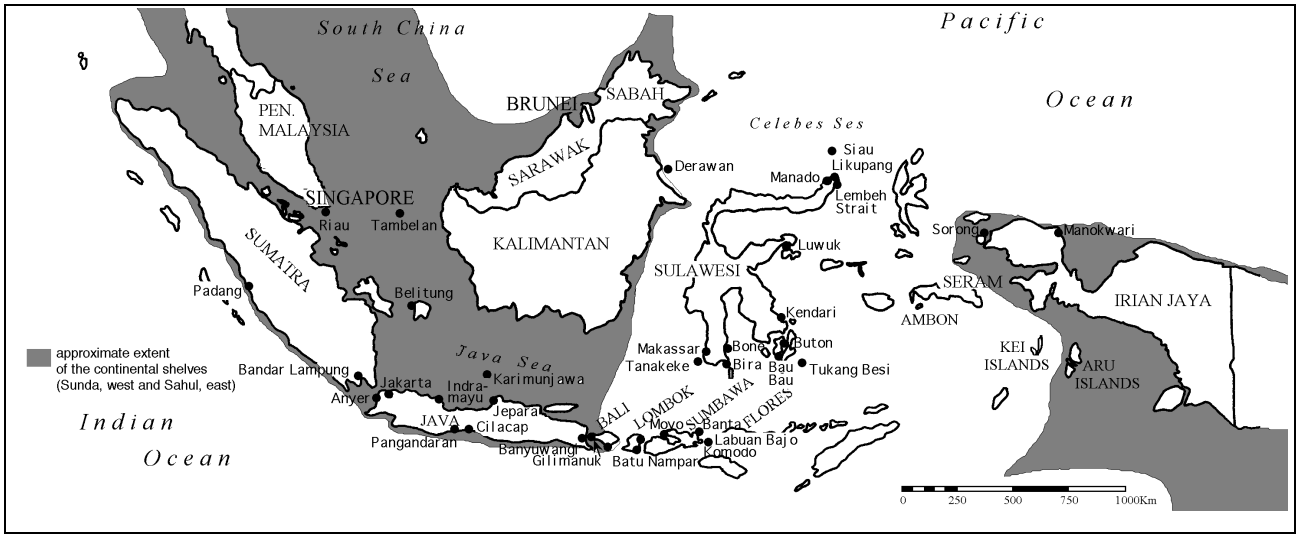
South China
Sea
Pacific
Ocean
BRUNEI
SABAH
PEN.
MALAYSIA
SARAWAK
Celebes Ses
Siau
Likupang
Derawan
Manado
Lembeh
Strait
SINGAPORE
Riau
Tambelan
KALIMANTAN
SUMATRA
Luwuk
Sorong
Manokwari
SULAWESI
SERAM
Padang
Belitung
Kendari
AMBON
IRIAN JAYA
approximate extent
of the continental shelves
(Sunda, west and Sahul, east)
Java Sea
Makassar
Bone
Buton
KEI
ISLANDS
Tanakeke
Bira
Bau
Bau
Tukang Besi
ARU
ISLANDS
Bandar Lampung
Jakarta
Karimunjawa
Anyer
Indra-
mayu
Jepara
LOMBOK
SUMBAWA
FLORES
BALI
Indian
Ocean
JAVA
Cilacap
Moyo
Banta
Labuan Bajo
Komodo
Pangandaran
Banyuwangi
Gilimanuk
Batu Nampar
0
250
500
750
1000Km

Table 1: Sources of information and their relative advantages and disadvantages.

Method of acquiring information	Level	Advantages of method	Potential sources of error
In-water surveys	1° source	allows collection of habitat/ depth information; exact location of live seahorses can be recorded; seahorses do not need to be killed	seahorses well camouflaged and may not be spotted; observers vary in their ability to spot seahorses; not random sample of the habitat - because so time-consuming, we usually focused on areas where seahorses had been reported by locals; habitat disturbance through fishing activity may result in seahorses being moved from their home range
Fishers	2° source	some habitat/ depth information may be available; often large scale searching/ sampling over long time frame; may be able to get information about spatial/ temporal changes in stock	different fishing techniques sample different habitats/ depths; large scale (temporal and spatial) of sampling may mean that location of individual specimens is forgotten; net fishers may not know what from habitat they are sampling; deliberate deception to avoid competition; mutual incomprehension of aims
Recreational divers	2° source	some habitat/ depth information can be recorded; accurate location can usually be determined; often accompanied by photograph for verification	not random sample of habitat because usually only reported if seahorses are found
Museum specimens	2° or 3° source	habitat/ depth information may be available; importance of such information is realised in this context, thus is likely to be accurate	few Indonesian specimens available in museums; usually preserved or fixed in formalin so not amenable to genetic studies; may be very old which introduces another variable dimension (time) into genetic studies
Traders	3° or higher level source	wide scale sampling; don't need to get wet	unlikely to know where fishers obtain seahorses; may obtain seahorses from many fishers, who in turn may use different techniques; mutual incomprehension of aims; deliberate deception for commercial gain; may include specimens imported from outside the local region
NGOs/ University researchers	2°, 3° or 4° source	if research focus is on seahorses this can provide very detailed information, otherwise subject to similar errors as above	variable information depending on their source of information (i.e. from personal in-water surveys, fishers, or traders)

Results:

Species Identifications

Nine species of seahorse were found to inhabit Indonesian waters (Appendix B, C). They are tentatively assigned to the following species: *Hippocampus barbouri, H. bargibanti, H. comes, H. histrix, H. kelloggi, H. kuda* (and *H. kuda?*), *H. spinosissimus, H. trimaculatus* and *H. sp. nov.* based on visual identification (table 2) (Lourie et al., 1999a,b). We saw *H. barbouri, H. bargibanti, H. comes, H. spinosissimus* and *H. sp. nov.* alive in their natural habitats during this research and the others came from fishers or other sources. To our knowledge, this is the first time that *H. barbouri*, *H. kelloggi* and *H. sp. nov.* have been recorded from Indonesia.

Species Distributions - information from fishers

Seahorses were found at more than 50 sites (separated by >100m), in 16 regions (separated by >100km) across Indonesia. We used a variety of methods, in the water and through interviews with locals to obtain this information. Table 3 lists positive records of the occurrence of seahorses found at these sites (also shown in maps 2-10, Appendix C). Entries in this table and these maps are of specimens (or photographs) verified by SL

and do not include literature citations because of the present confusion in seahorse taxonomy and difficulties with identification.

The most widespread, and commonly encountered species was *H. kuda*. *H. barbouri* was also relatively common in a few sites off South Sulawesi, Lombok and the Indian Ocean coast of Java, but apparently absent from further east or the Sunda Shelf region. These species seem to live closest in to shore and are often come across by inshore fishers (e.g. using beach seine, cast net, push net, dip net, wading, snorkeling or diving) or by children. *H. trimaculatus* and *H. spinosissimus* were both more commonly found in the western part of Indonesia (the Sunda Shelf region) than in the east and usually obtained from trawl or net fishers suggesting that they live at greater depths than the previous two species. However, these distribution patterns may be an artifact of the fishing methods that were used in the different areas e.g. most fishers on the Sunda Shelf were using trawls whereas off the Shelf there were more fishers using dip-nets or wading (Table 4). *H. kelloggi* was rarely encountered, but appears to also live in deeper waters. *H. comes* was only found in two locations.

In-water Surveys

In addition to obtaining information from fishers, traders and other sources, we spent over 350 person-hours searching for seahorses in the water, in areas where we had been told that seahorses had been found previously. During these semi-quantitative surveys we found a total of 165 individuals of five different species (*H. barbouri, H. bargibanti, H. kuda, H. spinosissimus* and *H. sp. nov.*). 104 of these were found in four locations on four days.

H. barbouri was found in two sites, both of which were very shallow with thick seagrass. *H. kuda* was also found in shallow water, usually in muddy areas, or regions with scattered seagrass. Only a single specimen of *H. spinosissimus* was seen during our surveys, at a depth of approximately 8m. It is likely that this species usually lives at greater depths and, with *H. trimaculatus*, was commonly obtained in trawl by-catch. The two pygmy seahorse species (*H. bargibanti* and *H. sp. nov.*) were found on gorgonian sea fans, never shallower than 11m.

The estimated number of seahorses found per linear metre (distances estimated) of our surveys ranged from: 0-0.25 in habitat 1 (<3m deep, seagrass/ mud/ sand), 0-0.73 in habitat 2 (3-35m, mud/ sand/ gravel), 0-0.03 in habitat 3 (3-35m, coral/ gorgonians). Note that effort was not standardised across surveys.

Table 2: Species of seahorse (*Hippocampus*) found during this study, their habitats, and methods used.

SPECIES	COMMON NAME	HABITAT	DEPTH	METHOD
H. barbouri	Barbour's seahorse	*Enhalus* seagrass	0-3m	snorkeling, push net

	-	beds		
H. bargibanti	Pygmy seahorse -	gorgonian sea fans (*Muricella sp.?*)	at least 15m	diving
H. comes	Tiger-tail seahorse -	coral reef, seagrass	less than 10m	diving, snorkeling
H. histrix	Thorny seahorse Tangkur kuda berduri	sponges and sea squirts	at least 6m	diving
H. kelloggi	Offshore seahorse -	deep water, exact habitat unknown	at least 10m	diving, trawling, boat seine
H. kuda	Common seahorse Kuda laut	sand, mud, scattered seagrass	0-8m	snorkeling, diving, beach seine, crab trap
H. spinosissimus	Hedgehog seahorse Kuda laut bermahkota	sand, sponges, coral reef	8-30m	diving, trawl
H. trimaculatus	Three-spot seahorse -	gravel, sandy bottoms	10-30m	diving, trawling, boat seine
H. sp. nov.	Yellow pygmy seahorse -	gorgonian sea fans (*Subergorgia sp.?*)	at least 10m	diving

Table 3: Seahorse distributions across Indonesia. Sites are only listed where seahorses were found and are listed roughly from west to east.

PROVINCE	REGION	SITE	SEA	GPS	HABITAT if known	DEPTH	SPECIES FOUND	SOURCE
Sumatra	Riau	Pulau Penyengat	Selat Dempo, South China Sea	approx. N 00°56' E104°25'	mud, seagrass	1-2m	*kuda (?)*	local fishers (found attached to crab traps, caught in nets, or by hand); local seahorse buyer
Sumatra	Riau	Kep. Tambelan	Laut Natuna South China Sea	approx. N 01°00' E107°30'	coral, seagrass	1-2m	*kuda*	local fisher (dip net)
Sumatra	Riau	Kep. Tambelan	Laut Natuna South China Sea	approx. N 01°00' E107°30'	?	15-20m	*spinosissimus, trimaculatus*	trawl boat
Sumatra	Padang	Pulau Pasumpahan	Selat Mentawai, Indian Ocean	S 01°07.166' E100°22.192'	sand, scattered seagrass	<1m	*kuda*	in-water survey (snorkel)
Sumatra	Padang	Batu Jarang	Selat Mentawai, Indian Ocean	S 01°07.413' E100°22.383'	sand, scattered seagrass	<1m	*kuda*	in-water survey (snorkel)
Sumatra	Padang	Pariaman	Selat Mentawai, Indian Ocean	-	?	?	*trimaculatus*	museum specimen (RMNH[1])
Sumatra	Belitung	Tanjung Kelayan	Selat Gaspar, South China Sea	approx. S 02°34' E107°42'	?	?	*kuda; spinosissimus*	local fishers (compressor divers)
Sumatra	Belitung	Tanjung Tinggi	Selat Gaspar, South China Sea	approx. S 02°33' E107°43	?	?	*kuda; spinosissimus*	local fishers (compressor divers)
Sumatra	Bandar Lampung	within 10 miles of Lempasing	Selat Sunda	approx. S 05°32' E105°17'	?	?	*trimaculatus*	fishers (trawl)
Sumatra	Bandar Lampung	Kampung Hanura	Selat Sunda	approx. S 05°32' E105°17'	?	?	*comes; kuda*	local fisher (diving and wading); local aquarium collector; Balai Budidaya Laut
Java	Anyer / Pantai Carita	Sangiang Island/ Panaitan Island	Selat Sunda	approx. S 06°28' E105°28'	coral	deep	*spinosissimus; trimaculatus*	local fisher (compressor diver and trawl)

[1] Institutional codes as listed in Levinton et al. (1985)

Java	Cilacap	within 30km	Indian Ocean	?	?	4-5m	*barbouri; kelloggi; kuda; trimaculatus*	souvenir shops; local fishers (boat seine); apparently many of the s/h come from Nusa Kambongan Island
Java	Pangandaran	Batununggul	Indian Ocean	S 07°42.407' E108°39.882'	sand, seagrass	<1m	*kuda*	in-water survey (wading)
Java	Pangandaran	Teluk Pananjung	Indian Ocean	S 07°42.236' E108°39.590'	mud	5-8m	*kuda*	in-water survey (snorkel)
Java	Indramayu	?	Laut Java	approx. S 06°15' E108°25'	?	20m	*trimaculatus*	Cirebon fisher (trawl)
Java	Karimunjawa	?	Laut Java	approx. S 05°53' E110°26'	sand, scattered gorgonians	15-25m	*spinosissimus; trimaculatus*	local fishers (trawl)
Java	Karimunjawa	Pulau Tengah	Laut Java	S 05°48.654' E110°30.453'	coral reef, sand, scattered gorgonians	13m	*sp. nov.*	in-water survey (SCUBA)
Java	Jepara	?	Laut Java	approx S 06°36' E110°37'	?	?	*trimaculatus*	local fishers (trawl)
Java	Banyuwangi	Muncar	Selat Bali	approx. S 08°26' E114°21'	coral reef; seagrass	deep	*kelloggi*	local fisher (compressor diver)
Kalimantan	Tanjung Redep	Pulau Derawan	Selat Makassar	approx. N 02°17' E 118°14'	seagrass	<2m	*kuda*	local villagers (wading)
Kalimantan	Tanjung Redep	Pulau Derawan	Selat Makassar	approx. N 02°17' E 118°14'	coral reef	?	*sp. nov.*	diver
Sulawesi	Sulawesi Selatan	Pulau Tanakeke	Selat Makassar	S 05°27.893' E119°18.380'	thick seagrass	<3m	*barbouri*	in-water survey (snorkel); local fishers (push-net)
Sulawesi	Sulawesi Selatan	Bira	Selat Selayar	approx. S 05°37' E120°29'	?	?	*kuda*	local villager
Sulawesi	Sulawesi Selatan	Bone	Teluk Bone	approx. S 04°33' E120°24'	?	<2m	*barbouri*	local villager (caught by hand)
Sulawesi	Sulawesi Tenggara	Tambo, Pulau Muna	Selat Buton	approx. S 04°37' E122°53'	?	?	*kuda*	TCM trader in Kendari
Sulawesi	Sulawesi Tenggara	Pulau Buton	Selat Buton	approx. S 04°50' E122°48'	?	?	*kuda*	local fisher (snorkeling)
Sulawesi	Sulawesi Tenggara	Bau Bau	Selat Buton	approx. S 05°27' E122°36'	?	?	*barbouri; kuda*	local sea cucumber fisher (snorkeling)
Sulawesi	Sulawesi Tenggara	Pulau Hoga	Laut Banda	approx. S 05°29' E122°46'	sand, seagrass	<2m	*kuda*	diver
Sulawesi	Sulawesi Tenggara	Sampela, Tukang Besi	Laut Banda	approx. S 05°27' E123°36'	sand, seagrass	<1m	*kuda*	local villager (caught by hand)
Sulawesi	Sulawesi Tenggara	Tanjung Pira, Kendari	Laut Banda	approx. S 03°59' E122°33'	mud flats	<2m	*kuda*	local villager (caught by hand)
Sulawesi	Sulawesi Tenggara	Nambo, Kendari	Laut Banda	approx. S 03°59' E122°33'	mud flats	<1m	*kuda*	local villager (caught by hand)
Sulawesi	Sulawesi Tengah	Luwuk, Kp. Bungin	Selat Pelang, Laut Sulawesi	approx. S 00°57' E122°53'	?	?	*kuda*	local fisher (caught locally)
Sulawesi	Sulawesi Tengah	Batui	Teluk Tolo	approx. S 01°16'S E122°33'	?	?	*trimaculatus*	local fisher (caught locally)
Sulawesi	Sulawesi Utara	Manado	Laut Sulawesi	approx. N 01°30' E124°50'	?	?	*kuda*	local fishers; local dive operators; NGO
Sulawesi	Sulawesi Utara	Manado	Laut Sulawesi	-	?	?	*trimaculatus*	museum specimen (BMNH)
Sulawesi	Sulawesi Utara	Bunaken	Laut Sulawesi	approx. N 01°37' E124°47'	?	?	*kuda*	local villager
Sulawesi	Sulawesi	Likupang	Laut Maluku	N 01°40.363'	mud/ sand,	<2m	*kuda*	in-water survey

	Utara			E125°04.403'	stones			(snorkel)
Sulawesi	Sulawesi Utara	Lembeh Strait	Selat Lembeh, Laut Maluku	N 01°28' E125°14'	black sand	12m	*trimaculatus*	diver
Sulawesi	Sulawesi Utara	Lembeh Strait	Selat Lembeh, Laut Maluku	N 01°28' E125°14'	?	?	*histrix*	diver
Sulawesi	Sulawesi Utara	Lembeh Strait	Selat Lembeh, Laut Maluku	N 01°28' E125°14'	black sand	17m	*spinosissimus*	diver
Sulawesi	Sulawesi Utara	Lembeh Strait (Labuhan Tokambahu)	Selat Lembeh, Laut Maluku	N 01°29.422' E125°14.215'	black sand	4-8m	*kuda; spinosissimus*	in-water survey (SCUBA)
Sulawesi	Sulawesi Utara	Lembeh Strait (Jahir)	Selat Lembeh, Laut Maluku	N 01°28.744' E125°14.164'	coral reef; gorgonians	20m	*bargibanti*	in-water survey (SCUBA)
Bali	Bali Barat	Gilimanuk	Selat Bali	S 08°09.847' E114°26.292'	mud/ sand	3-6m	*kuda*	in-water survey (SCUBA)
Lombok	NE Lombok	Pulau Petagan and Pulau Lampu	Selat Alas	approx. S 08°26' E116°44'	?	?	*barbouri; kuda*	local fishers, caught locally
Lombok	SE Lombok	Pulau Gilikaliaratan	Selat Alas	?	?	?	*barbouri*	local fishers in Jrowari
Lombok	SE Lombok	Batu Nampar	Indian Ocean	approx. S 08°52' E116°24'	sand, seagrass	<1m	*barbouri; kuda*	in-water survey; local fishers (caught by hand)
Lombok	SE Lombok	Batu Nampar	Indian Ocean	approx. S 08°52' E116°24'	edge of reef	>30m	*trimaculatus*	local fishers (using net)
East Nusa Tenggara	Sumbawa	Pulau Banta	Laut Flores	S 08°24' S E119°17'	coral reef; gorgonians	11-35m	*bargibanti; sp. nov.*	in-water survey (SCUBA)
East Nusa Tenggara	Komodo	?	Selat Sapeh	-	?	69m	*spinosissimus*	museum specimens (ZMA)
East Nusa Tenggara	Komodo	Komodo	Selat Lintah	approx. S 08°35' E119°30'	?	?	*kuda*	local villagers
East Nusa Tenggara	Flores	Maumere Bay	Laut Flores	approx. S 08°38' E122°13'	?	5-10m	*kuda*	museum specimen (MWA)
East Nusa Tenggara	Flores	Labuan Bajo	Laut Flores	approx. S 08°29' E119°53'	floating	?	*trimaculatus*	local villagers
East Nusa Tenggara	Flores	Labuan Bajo	Laut Flores	approx. S 08°29' E119°53'	?	?	*kelloggi; kuda*	local villagers
East Nusa Tenggara	Alor	Alor Kebola Bay, SW side	Laut Flores	S 08°16.5' E124°26.3'	?	?	*histrix*	museum specimen (BPBM)
Maluku	Damar Island	?	Laut Banda	-	?	?	*spinosissimus?*	museum specimen (BMNH)
Maluku	Ambon	?	Laut Banda	-	?	?	*kuda*	museum specimen (BMNH, RMNH, MNHN)
Irian Jaya	Manokwari	Kampung Ambon	Selat Woinui, Pacific Ocean	S 00°52.463' E134°04.784'	sand/ mud, scattered seagrass	<2m	*kuda*	in-water survey (snorkel)
New Guinea		Havre Dorey	Laut Arafura	S 07°30'S E132°30'	?	?	*kuda*	museum specimen (MNHN)

Table 4: Species found in relation to gear used by fishers (or recreational divers) from whom we obtained information in different areas.

Area	**Location with respect to Sunda Shelf**	**Gear used by fishers (or recreational divers) from whom seahorses were seen and identified**				**Species found**
		wading/ dipnet	snorkeling	diving	trawl/ boat seine	
Bintang	on	√	√	-	-	*kuda?*
Padang	on	√	-	-	-	*kuda*
Belitung	on	-	-	√	-	*kuda, spinosissimus*

Lampung	on	√	√	√	√	*comes, kuda, trimaculatus*
Carita	on	-	-	-	√	*spinosissimus, trimaculatus*
Karimunjawa	on	-	-	-	√	*spinosissimus, trimaculatus*
Jepara	on	-	-	-	√	*spinosissimus, trimaculatus*
Cilacap	on	√	√	√	√	*barbouri, kelloggi, kuda, trimaculatus*
Banyuwangi	on	-	-	√	-	*kelloggi, spinosissimus*
Gilimanuk	on	-	-	√	-	*kuda, spinosissimus, trimaculatus, bargibanti*
Lombok	off	√	-	-	√	*barbouri, kuda, trimaculatus*
Labuan Bajo	off	√	-	-	-	*kuda*
Tanakeke	off	√	-	-	-	*barbouri, comes*
Buton	off	-	√	-	-	*kuda*
Bau Bau	off	-	√	√	-	*kuda*
Tukang Besi	off	√	-	√	-	*kuda*
Lembeh Strait	off	-	-	√	-	*kuda, histrix, spinosissimus, trimaculatus*
Manokwari	off	√	√	-	-	*kuda*

Discussion:

Little is known about most seahorse species in the wild, including those found in Indonesia. This rapid assessment of the taxonomy and distribution of seahorses in Indonesia can provide a foundation for future research.

The results of this study show that more species of seahorse are found in Indonesian waters than was previously realised. Indeed, more species of seahorse are recognised now from Indonesia than any other country in Southeast Asia: compare with the Philippines (seven species), Vietnam (seven species), Thailand (five species), Japan (eight species), and second only to Australia which has at least ten species (Lourie et al., 1999a, *pers. obs.*). We visually identified all the specimens to species level during our survey without difficulty except for three orange pygmy seahorse specimens which we believe to be a new species (*H. sp. nov.*) and specimens from Penyengat Island near Bintang, Riau, which we have currently identified as *H. kuda?* but which differ from other specimens identified as *H. kuda* in the development of their spines and coronet. These will be the subject of further investigation. In addition, preliminary analyses suggesting that that specimens of *H. trimaculatus* found on, versus off the Sunda Shelf, may be genetically distinct and require a re-evaluation of the validity of this species. Cursory visual examination however, suggests no major morphological differences.

Seahorses occur throughout the Indonesian archipelago, and seven of the nine species (using our current classification system) were found on the Sunda Shelf (*H. barbouri* was only found on the Indian Ocean edge and not on the central part of the Shelf, and *H. histrix* and *H. bargibanti* were not seen on the Shelf), and all nine were found off the Shelf. This suggests that seahorses may have a wider range than initially thought and all

species may occur in all areas given further searching. Suggestions that *H. spinossisimus* and *H. trimaculatus* are more common on the Shelf, and *H. kuda* and *H. barbouri* are more common off the Shelf, may have more to do with the fishing practices used, than with a biological reality.

In addition to any geographic patterns that may emerge, this research seems to show that seahorse species are stratified by depth and habitat, with *H. kelloggi, H. spinosissimus* and *H. trimaculatus* inhabiting deeper water probably in areas of sand, mud, gravel and scattered gorgonians, and *H. barbouri* and *H. kuda* in shallower areas with seagrass or mud. *H. comes* may be mainly a coral reef species (although too few specimens were seen to confirm this), and the two pygmy seahorses (*H. bargibanti* and *H. sp. nov.*) are very specific in their habitat requirements, living only on certain species of gorgonian seafan.

Our in-water surveys provided very crude estimates of density of seahorses in the wild (primarily for *H. barbouri* and *H. kuda*). These corroborate previous studies (e.g. Vincent and Sadler, 1995 for *H. whitei*; Perante, 1998 for *H. comes*) which suggest that many seahorse species usually live at relatively low densities. Caution should be exercised to prevent over-exploitation, by-catch and habitat destruction from endangering their wild populations.

Future Directions:

This report represents the initial findings on the taxonomy and distribution of Indonesian seahorses. Further research comparing Indonesian specimens with those from Vietnam, and other areas in Asia, using morphological and genetic analysis will be carried out on my return to Canada. Genetic data will also be used to assess the level of genetic connection (based on mitochondrial cytochrome *b* sequence and potentially microsatellites) among populations of *H. kuda, H. trimaculatus* and *H. barbouri*. Such information on the scale of endemicity of seahorse species will be very important for appropriate regional-level conservation planning.

In addition, a formal description of *H. sp. nov.* will be made. Future research is likely to uncover more pygmy seahorse species in Indonesian waters. We have already seen photographs of a white, and a brown, marbled species which may well be new to science.

Qualitative data on population numbers were obtained during this research. More rigorous, standardised, and repeated population surveys need to be done, particularly in areas (such as the Riau Archipelago, Lombok and Tanakeke Island) where relatively large-scale exploitation is occurring in order to monitor the long-term effects of such activities and in order to ensure that they are sustainable. Declines in population numbers of seahorses in other regions (such as the Philippines) should provide a warning to Indonesia to take such action before problems are encountered.

Simple measures could be used to help lower the impact of fishing in these areas. For example, if pregnant males that are captured are allowed to give birth in the water (e.g. in a cage) before they are sold, this could help sustain the fishery by increasing the number of offspring in the water (Pajaro & Vincent, 1998). In Pulau Penyengat, Riau, out of 35 seahorses caught on one day almost all the males (15) were pregnant (*pers. obs*.). This could represent a loss of over 6000 seahorses (assuming each male carries on average 410 young (Qodri et al., 1999)). Even though natural survivorship of the young to adulthood is believed to be relatively low, if these adults are sold with the young still inside them, the potential for them to contribute to the next generation is definitely lost.

Feedback:

An integral aim of this study was to disseminate information about seahorse taxonomy and to train Indonesian scientists in seahorse identification. During my research I have worked with, and directly trained three Indonesian marine biology students, two museum scientists and six members of marine NGOs in seahorse identification. I gave talks on seahorses and conservation at Hasanuddin University (Makassar, Sulawesi), Terangi (Indonesian Coral Reef Foundation, Jakarta), Kungkungan Bay Resort (Lembeh Strait, Sulawesi), Operation Wallacea (Tukang Besi Archipelago) and on board the MV Pindito. I was also in contact, and had discussions with numerous other researchers and marine NGOs (see Appendix A). Where possible/ appropriate, I donated copies of Lourie et al. (1999) 'Seahorses: an identification guide to the world's species and their conservation' to organisations listed in Appendix A.

Specimens of all Indonesian seahorse species, including the new pygmy seahorse, will be deposited at the Museum Zoologicum Bogoriense - Puslitbang Biologi - Lembaga Ilmu Pengatahuan Indonesia in Bogor for future reference by Indonesian and international scientists, and results of this study will be sent to all people and organisations who provided assistance with this project.

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Susan Jewett, Stewart McConnell, Max Ammer, Walter Erdelen, Haryono, Arief Wicaksono, Jan Steffan, Mimi and Via, Junita Mandagi, Jemmy Souhoka, Mr Udin, Mark and Arnaz Erdmann, Ibu Ita, Abang, Denise and Larry Tackett, Mark Ecenbarger, Bruce Moore, Johnnes Tulungen, Tirce Luas, Tim Coles, Guillermo Moreno, Vicky Clarke, Akhirrudin, Clara Tuelah Bundt, Fathuddin, Yusuf Syafyudin, Irfan Ambar, Iqbal Djawad, Katherine Monk, Sehan Umar, Didet, Ali Hafiz al Qodri, Norman, Nelvy, Budy Wiryan, Indrajunaidi, Ucok, Heri, Mrs Anin, Mr Sudjiharno, Mohammed Iqbal Malik, the inhabitants of Lantan Peo and Tambelan and the many other people who helped along the way.

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APPENDIX A:

Contacts:

Yayasan Jari, Mataram, Lombok

Puslitbang Biologi - LIPI, Cibinong, Java

Project Pesisir, Jakarta, Java

International Marine Life Alliance, Bogor, Java

Fakultas Perikanan dan Ilmu Kelautan, Institut Pertanian Bogor, Java

WWF, Den Pasar, Bali

Dive and Dive's, Sanur, Bali

Komodo National Park Foundation, Labuan Bajo, Flores

The Nature Conservancy, Labuan Bajo, Flores

Puslitbang Oceanologi - LIPI, Ancol, Jakarta

COREMAP – Coral Reef Rehabilitation and Management Program, Jakarta

Stasiun Penelitian LIPI –Bitung, N. Sulawesi

Project Pesisir, Manado, N. Sulawesi

Fakultas Perikanan dan Ilmu Kelautan, Sam Ratulangi University, Manado, N. Sulawesi

Faculty of Marine Science and Fisheries, Hasanuddin University, Makassar, S. Sulawesi

Operation Wallacea, Tukang Besi Archipelago, SE. Sulawesi

Yayasan Alam Karimun, Karimunjawa

Karimun Divers, Semarang, C. Java

Yayasan Minang Bahari, Padang, W. Sumatra

Balai Budidaya Laut, Lampung, S. Sumatra

Terangi (Indonesian Coral Reef Foundation), Jakarta

Kungkungan Bay Resort, Lembeh Strait, N. Sulawesi

MV Pindito, Bali

APPENDIX B:

Key to the Indonesian seahorse species:

1a. Adult height (vertical measure from coronet to tail tip) much less than 3cm ..... go to 2
1b. Adult height much more than 3cm ..... go to 3

2a. Body covered in enlarged tubercles; snout length less than 0.25 in head length; coronet a large rounded knob; colour in life pale grey/ purple with white striations, tubercles red/ pink ..... *H. bargibanti*
2b. Few, or no enlarged tubercles on body; snout length more than 0.30 in head length; no coronet or only a shallow mound; colour in life yellow/ orange with scattered orange dots and no white striations..... *H. sp. nov.*

3a. Junctions of body plates extended into spines ..... go to 4
3b. Junctions of body plates not extended into spines, body relatively smooth ..... go to 6

4a. Snout striped (stripes usually retained in preserved specimens), double spines on either side of throat; prominent spine in front of coronet; prominent spines above eyes; prominent spine between eyes on snout ..... *H. barbouri*
4b. Snout not striped, single (or double) spines on either side of throat ..... go to 5

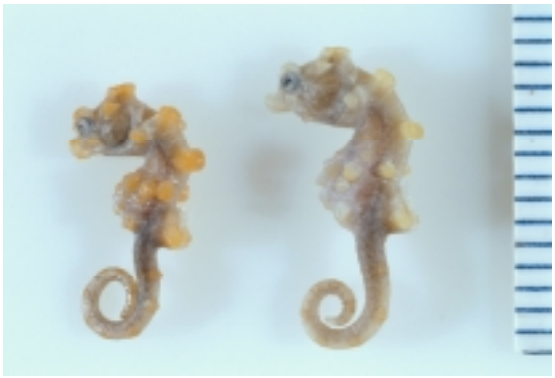
5a. Snout length more than 0.50 in head length; sharp spine between eyes ..... *H. histrix*
5b. Snout length less than or equal to 0.50 in head length; no sharp spine between eyes (or very small) ..... go to 7
5c. Snout length less than or equal to 0.50 in head length; sharp spine between eyes on snout; spines usually low with rounded tips; tail often striped (retained in preservation) ..... *H. comes*

6a. Coronet very low; head depth (from groove in coronet to behind cheek spine) less than 0.50 in head length; spines bordering the throat curved backwards and hook-like ..... *H. trimaculatus*
6b. Coronet variable, low, rounded or high; head depth more than 0.50 in head length; spines bordering throat roundedgo to 8

7a. Tail rings 35-37 (adult height always less than 20cm); spines bordering throat single or double, usually sharp and directed laterally ..... *H. spinosissimus*
7b. Tail rings 39-41 (adult height may be more than 20cm); spines bordering throat long, rounded and curved backwards . *H. kelloggi*

8a. Tail rings 39-41; body narrow; rings thickened ..... *H. kelloggi*
8b. Tail rings 35-37 (occasionally 34 or 38); body deep; rings not excessively thickened ..... *H. kuda*

The following figures show specimens of the Indonesian seahorse species. In each case the female is on the left and the male is on the right. The photographs of *H. comes* and *H. histrix* are from Vietnam as Indonesian examples were unavailable. Both of these specimens are females. The scale bar is in cm (with mm divisions).



Hippocampus bargibanti

Hippocampus sp. nov.

Hippocampus barbouri

Hippocampus histrix *Hippocampus comes*

Hippocampus trimaculatus

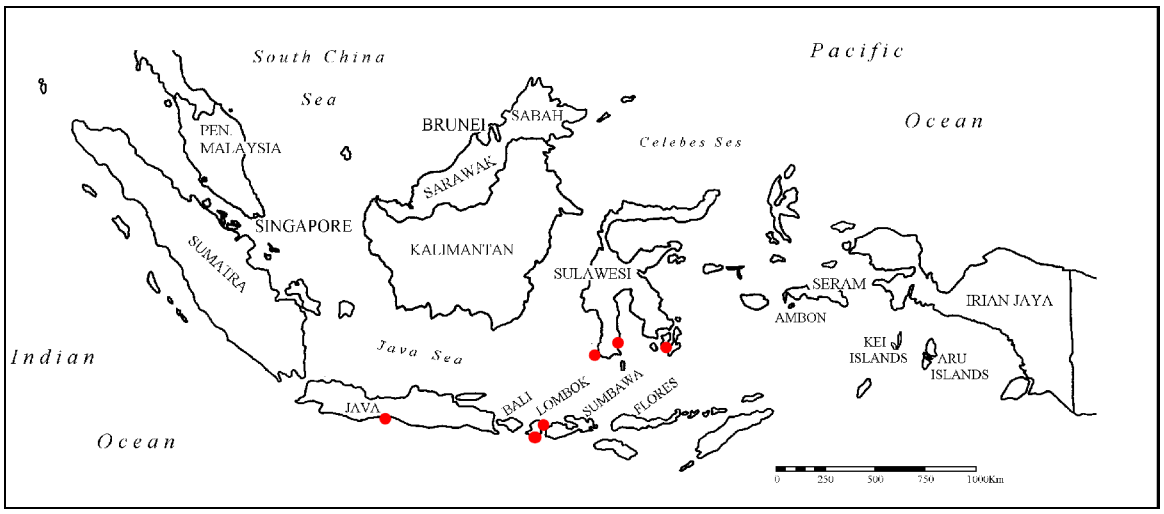
Hippocampus spinosissimus

Hippocampus kelloggi

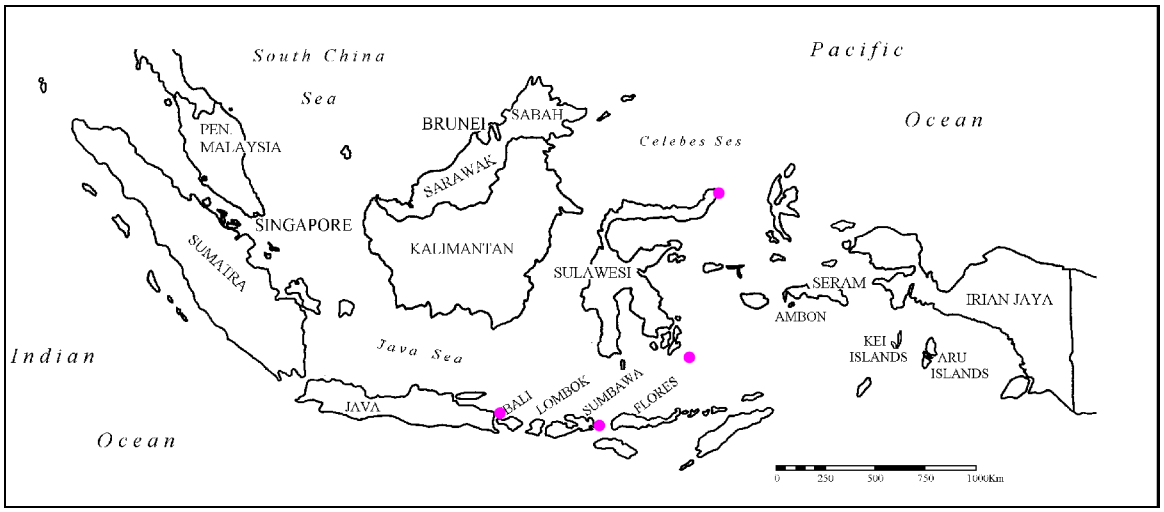
Hippocampus kuda

APPENDIX C:

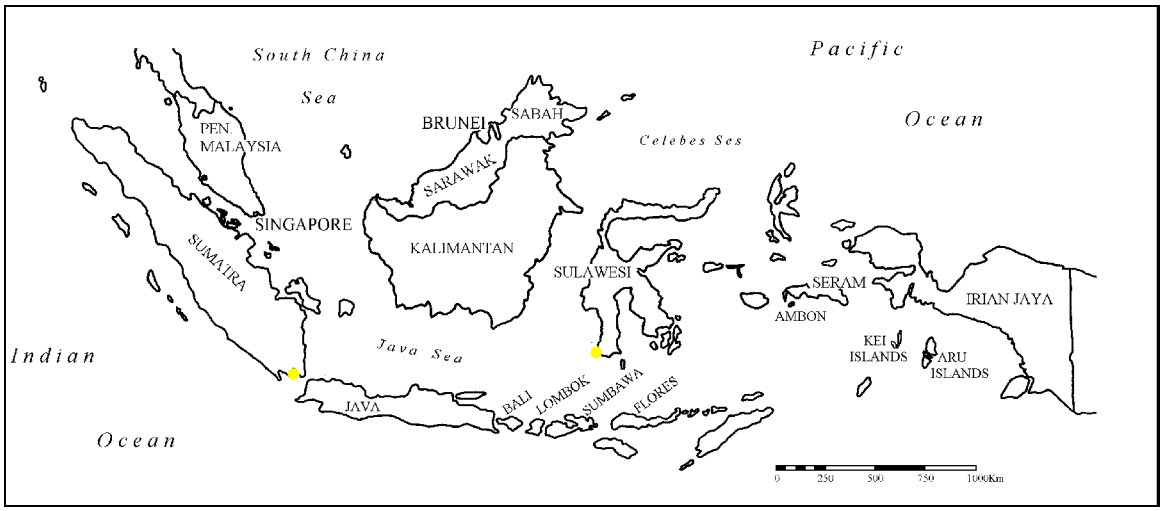
Species distribution maps:



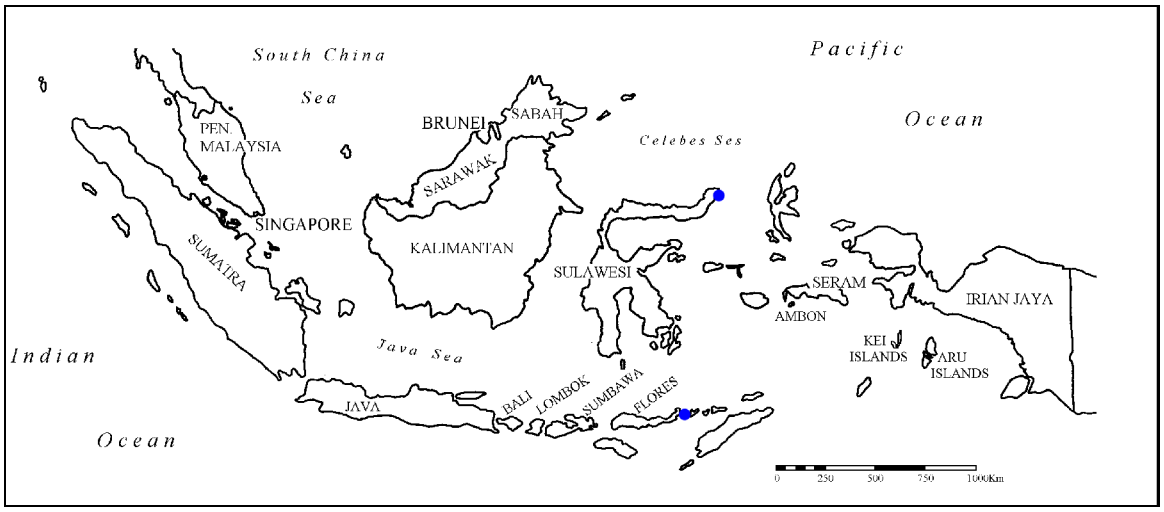
Distribution records for *H. barbouri*



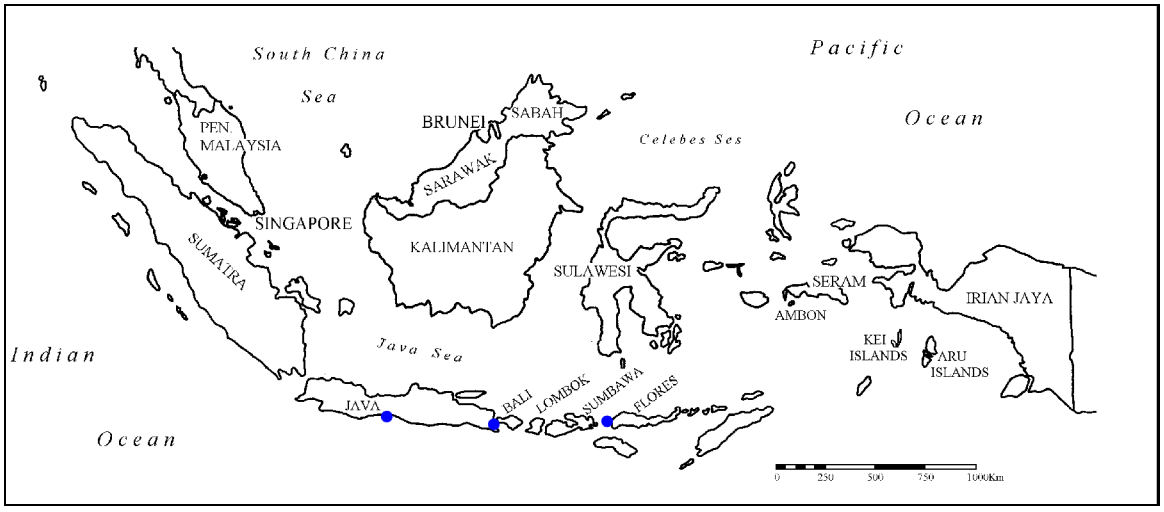
Distribution records for *H. bargibanti*



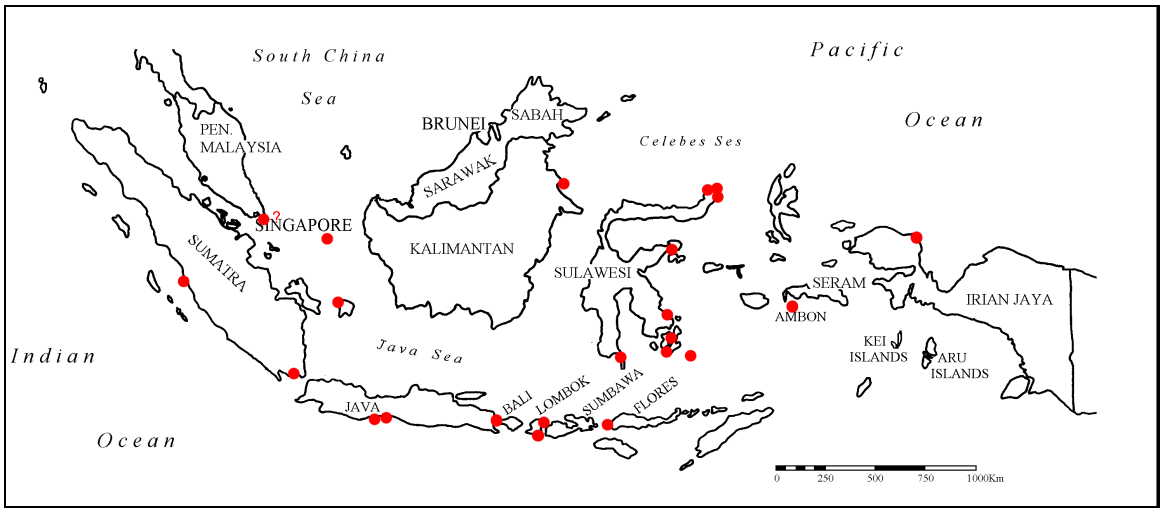
Distribution records for *H. comes*



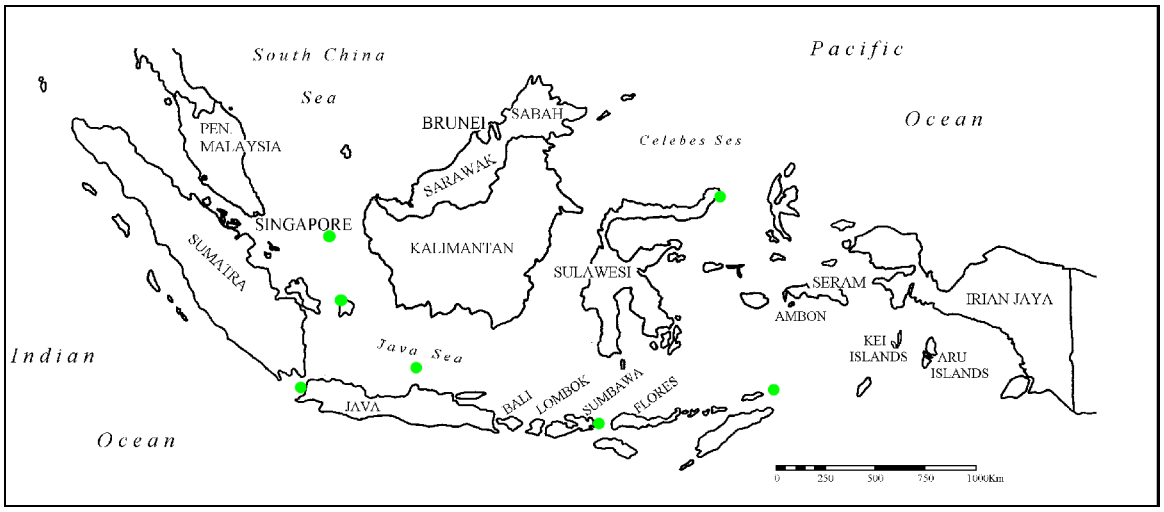
Distribution records for *H. histrix*



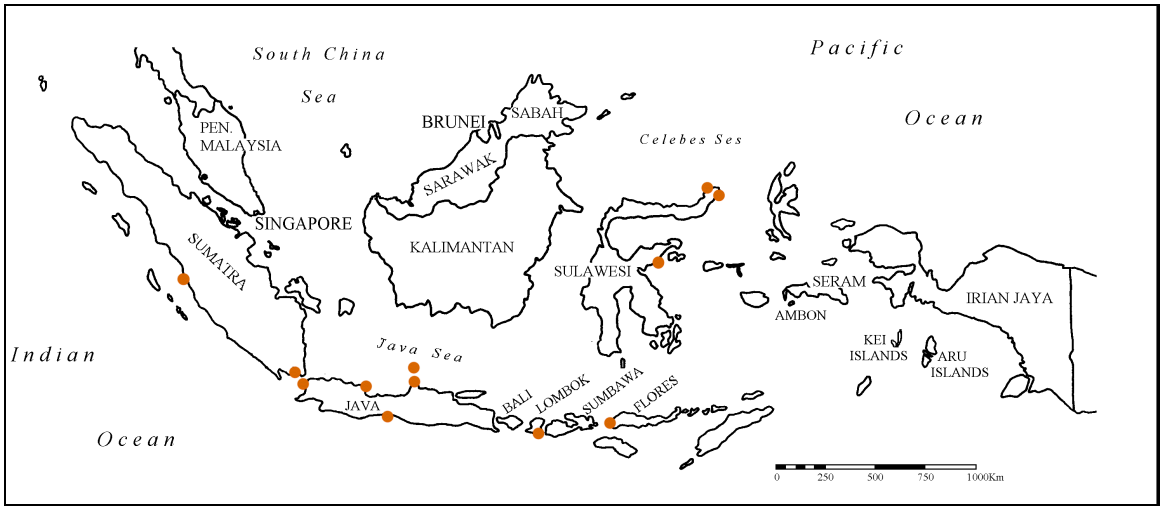
Distribution records for *H. kelloggi*



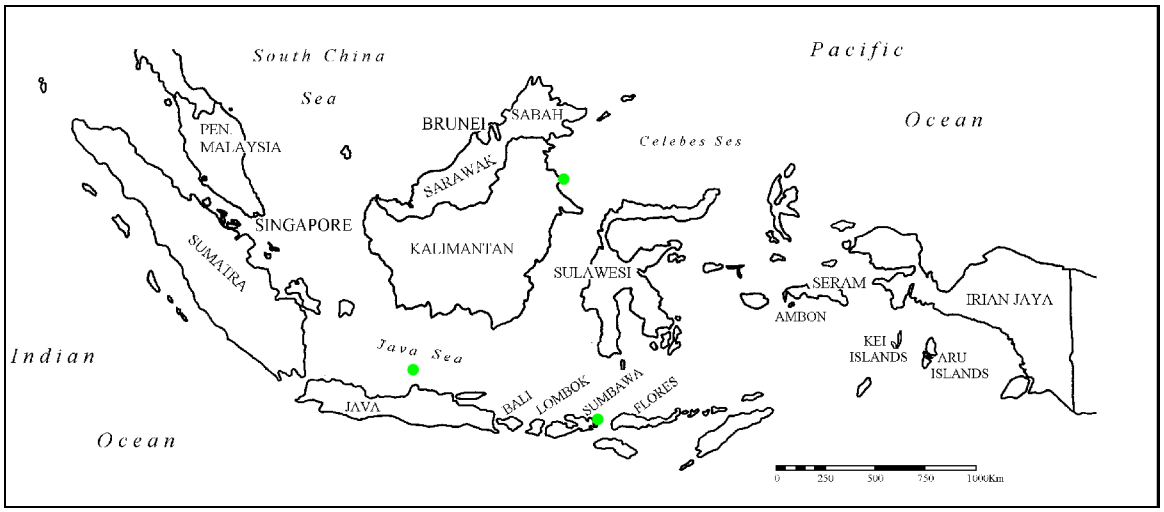
Distribution records for *H. kuda*



Distribution records for *H. spinosissimus*



Distribution records for *H. trimaculatus*



Distribution records for *H. sp. nov.*