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IDENTITY OF INTRODUCED SNAKEHEADS (PISCES, CHANNIDAE) IN HAWAI'I AND MADAGASCAR, WITH COMMENTS ON ECOLOGICAL CONCERNS

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Cover: Head of *Channa maculata*. Photo: Mike Yamamoto.

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Identity of Introduced Snakeheads (Pisces, Channidae) in Hawai‘i and Madagascar, with Comments on Ecological Concerns

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Introduction

Jordan & Evermann (1902a) and Cobb (1902) reported a snakehead, genus *Ophicephalus* and using a common name of “China-fish”, as having been introduced to waters in O‘ahu, Hawai‘i before 1900. Jordan & Evermann (1905) identified this fish as *Ophicephalus striatus* Bloch (= *Channa striata*, the chevron snakehead) based on 10 specimens collected from O‘ahu. Specimens collected under auspices of the U.S. Bureau of Fisheries beginning in 1896 were subsequently deposited at the American Museum of Natural History (AMNH), New York; Bernice Pauahi Bishop Museum (BPBM), Honolulu; California Academy of Sciences (CAS), San Francisco; Stanford University (SU, now deposited at CAS); Field Museum of Natural History (FMNH), Chicago; Museum of Comparative Zoology (MCZ), Harvard University, Cambridge, Massachusetts; and U.S. National Museum (USNM), Washington. All ensuing reports of a snakehead species in Hawai‘i followed the Jordan & Evermann (1905) identification. Those reports included Jordan & Evermann (1905), Evermann & Seale (1907), Smith (1907), Jordan & Jordan (1923), Mainland (1939), Tinker (1944), Brock (1952, 1960), Hida &Thomson (1962), Kanayama (1968), Lachner *et al*. (1970), Devick (1978, 1991), Timbol & Maciolek (1978), Courtenay & Hensley (1980), Morita (1981), Welcomme (1981, 1988), Maciolek (1984), Courtenay (1990), Courtenay *et al*. (1991), Robins *et al*. (1991), Courtenay (1992), Courtenay (1993), Eldredge (1994), Lever (1996), Fuller *et al*. (1999), and Yamamoto & Tagawa (2000). Morita (1981) also included Kaua‘i in the Hawaiian range of this fish, but Hawai‘i Department of Land and Natural Resources biologist Don Heacock (pers. comm. 2003 to Mike Yamamoto) advised that to his knowledge, “there are no snakeheads on Kaua‘i.”

During preparation of a biological synopsis and risk assessment analysis of snakehead fishes for the U.S. Fish and Wildlife Service during 2001–2002 by U.S. Geological Survey (USGS) biologists, one of us (WRC) recognized that the photographs of what was identified as *Channa striata* in Yamamoto & Tagawa (2000), locally called *pongee* or *i’a pākē*, were not that species but, rather *C. maculata* (Lacépède), the blotched snakehead. Research for the synopsis also found that during fiscal year 1999, the U.S. Department of Agriculture Small Business Innovation Program had funded a Phase II project to the Hawaii Seafood Company of Waialua to develop commercial culture of *C. striata*. Phase I research, conducted at the University of Hawaii and funded by the Aquaculture Development Program, Department of Land and Natural Resources, State of Hawaii, had established feasibility of rearing *C. striata* in captivity, captive spawning, and included studies on rearing juveniles on artificial diets (Qin & Fast, 1996a,b,c; Qin *et al*., 1997; Qin, Fast, & Kai, 1997; Qin & Fast, 1997; Qin & Fast, 1998). Phase II was targeted to pro-

Figure 1. Head of *Channa maculata* from O'ahu. Photograph by Mike Yamamoto.

Figure 2. *Channa maculata* from O'ahu. Photograph by Mike Yamamoto.

duction of larvae and juveniles through induced spawning, additional studies on feeding, and cost-effective growout performance to marketable size.

The photographs in Yamamoto & Tagawa (2000) and information on recent culture of *Channa striata* raised several questions. Were there two species of snakeheads in Hawai'i? If so, had both been there prior to 1900 or had one been imported at a later date? Had the stock being used in culture come from resident or imported fish? A series of seemingly unrelated events associated with the biological synopsis and risk assessment analysis of snakeheads by USGS biologists began to yield answers.

In late 2001, Karsten Hartel (Museum of Comparative Zoology, Harvard University) purchased two live snakeheads in an oriental food market in Boston and sent them by overnight shipment to the USGS Center for Aquatic Resources Studies, Gainesville, Florida. One arrived alive and the other, which died in transit, was preserved. The second specimen died in early July 2002 and was also preserved. No attempt was made to identify the preserved specimens because they appeared, superficially, to be *Channa argus* (Cantor; northern snakehead), a species known to be available for sale in ethnic live food fish markets in some parts of mainland U.S. and Canada. *Channa argus* is native from the Chang-Jiang (Yangtze) River basin northward to the Amur River and its tributaries along

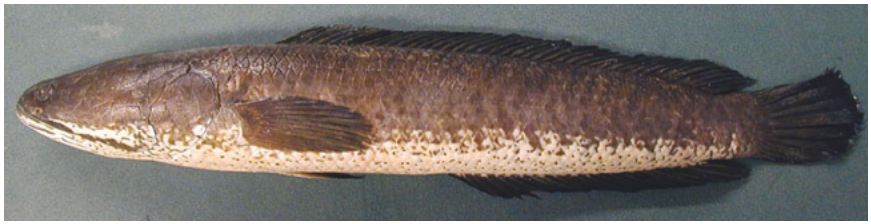

Figure 3. *Channa striata*, purchased from a market in San Diego, California, in July 2002 by Richard H. Rosenblatt. Photograph by Philip A. Hastings.

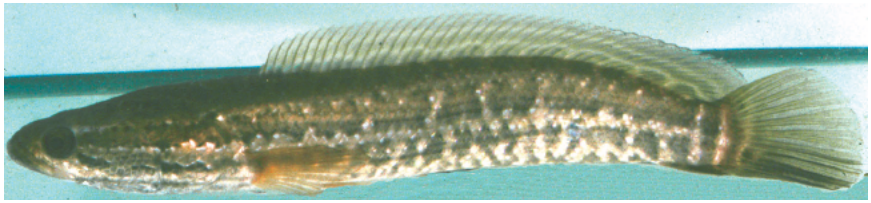

Figure 4. Young *Channa maculata* from the Sambava River drainage of northeastern Madagascar, Fall 1999. Photograph by Paul V. Loiselle.

the Chinese-Siberian border (Kimura, 1934; Nichols, 1943; Mori, 1952; Okada, 1960; Berg, 1965; Chu & Chen, 1990; Ding, 1994; Li & Xu, 1995), and is a predatory species that could establish throughout most of the mainland U.S. and perhaps waters of Hawai‘i and southern Canadian provinces.

On 23 July 2002, the Secretary of the Interior announced a proposed rule to list the family Channidae (snakehead fishes) as injurious wildlife under the Lacey Act (18 U.S.C. 42). On display at the news conference was one of the preserved specimens supplied by USGS that had been purchased in Boston in November 2001. At the request of USGS, that specimen, thought to be *Channa argus*, was subsequently deposited in the fish collection of the Smithsonian Institution’s National Museum of Natural History. On arrival, it was examined by Ralf Britz who discovered that it was not *C. argus* but a similarly marked species, *C. maculata*. This was the first evidence that *C. maculata*, like *C. argus,* was available in live food fish markets. Britz subsequently examined a specimen (USNM 126588) at the National Museum of Natural History labeled as *C. striata*, collected by Jordan and Evermann on O‘ahu in 1901, to find that it was *C. maculata*. *Channa maculata* is native to southern China, south of the Chang-Jiang basin, and Hainan (Nichols, 1943; Okada, 1961; Hay & Hodgkiss, 1981; Uyeno & Arai, 1984), and northern Vietnam (Kottelat, 2001). The introduced range of this snakehead includes Taiwan, Japan (Okada, 1961; Hay & Hodgkiss, 1981; Uyeno & Akai, 1984; Shen & Tzeng, 1993; Hosoya, 2002), and the Philippines (Uyeno & Akai, 1984). Thus began our examination of all known specimens of “*C. striata*” from collections made in Hawai‘i since the late 1800s and an inquiry to determine if more than one species of snakehead was now present there.

In a somewhat similar situation to that in Hawai‘i, Raminosoa (1987) reported *Channa striata* as having been introduced to Lac Itasy, a crater graben lake at 1800 m in the central high plateau of Madagascar in 1978 where it subsequently has become established. This initial identification was followed by Welcomme (1988), Reinthal & Stiassny

(1991), Stiassny & Raminosoa (1994), Lever (1996), Lévêque (1997, 1998), and Raminosoa *et al*. (2002). While examining specimens of snakeheads from Madagascar at the American Museum of Natural History, Ralf Britz discovered that they, too, were *C. maculata* and not *C. striata*.

Materials and Methods

Material examined. Number of specimens and range of standard length in mm (no measurements for Madagascar specimens) given in parentheses following catalog number.

Channa argus: UF 128571 (1, 245) Fish market in St. Louis, St. Louis County, Missouri, July 2002; UF 129400 (3, 327-339) Confiscated by Florida Game and Freshwater Fish Commission from P. K. Oriental Market in Pembroke Pines, Broward County, Florida, 14 February 2001; UF 133642 (2, 318-328) from Asian market in Orlando, July 2002; UF 133644 (1, 308) from fish market in Houston, Harris County, Texas, 2001; UF 133645 (1, 325) from Chinatown Restaurant and Market, Orlando, Orange County, Florida, 16-July 2002.

Channa maculata: **MADAGASCAR**: AMNH 88004 (2), AMNH 88006 (1), AMNH 97041 (3), AMNH 97367 (1), AMNH 231379 (9). **HAWAI'I: O'ahu**: AMNH 2377 (1, 142) Hawai'i, U.S. Fish Commission, 1896; BPBM 1759 (1, 189) Honolulu, Hawaiian Islands, U.S. Fish Commission, 1901; BPBM 3798 (1, 279) Honolulu, Hawaiian Islands, 1898 or 1901; CAS 17710 (1, 220) Hawai'i; CAS 108133/SU 8133 (3, 155-227) Hawai'i, Honolulu, U.S. Fish Commission; FMNH 4235 (1, 189) Hawaiian Islands, U.S. Fish Commission Hawaiian Expedition, 1901; MCZ 28942 (1, 129) Hawaiian Islands, U.S. Fish Commission, 1903; USNM 051027 (1, 276) Hawai'i, Hawaiian Islands, U.S. Fish Commission; USNM 126588 (1, 160) Hawai'i, Hawaiian Islands, Honolulu, D.S. Jordan & B.W. Evermann, 1901.

Channa striata: UF 128465 (5, 307-338 mm) **HAWAI'I:** Honolulu: Wah Wah Seafood Company, Pam Fuller, 16 September 2002

Methods of counting and measuring follow those of Hubbs and Lagler (1958) except for one. Rows of interorbital scales are counted across the least distance between the orbits.

Results

Based on material examined and the photographs in Yamamoto & Tagawa (2000), we conclude that *Channa maculata* (Figs. 1, 2) was the snakehead species originally introduced into Hawai'i. Because there were no known surveys of the fish fauna of Hawai'i prior to that of the U.S. Fish Commission beginning in 1896, a date of introduction cannot be determined. Furthermore, geographic source of the introduced stock is unknown. Jordan & Evermann (1905) indicated Borneo as the source, but *C. maculata* does not occur in Kalimantan (Borneo). Introduction of this species to Japan began in 1910 with stock from an introduced population in Taiwan released in Sakai, Osaka (Kawanabe *et al*., 2002), thus ruling out Japan as a source. Date of introduction of *C. maculata* to Taiwan from mainland China is unknown, but this would have been a closer source for transfer to Hawai'i. Another possible source, even closer, is the Philippines, but date and origin of introduced *C. maculata* there are also unknown. Nevertheless, the native range in southern China could have also been the source of exportation. Cobb (1902) indicated China as the origin. Moving airbreathing snakeheads across the Pacific, even well before engine-powered vessels, would not have been a difficult task.

There are two snakehead species in Hawai'i, *Channa maculata* (Figs.1, 2), introduced in the 1800s into ponds and irrigation ditches (Jordan & Evermann, 1902a; Cobb, 1902), and *C. striata* (Fig. 3), imported in 1994 and presently occurring only within an aquaculture facility on O'ahu.

Based on photographs and examination of specimens from Madagascar deposited at AMNH, all are *Channa maculata* (Fig. 4). The history of the introduction of *C. maculata* to Madagascar, where this fish is called fibata, is better known. The species was introduced between 1976 and 1978 by then-President Didier Ratsiraka who had seen snakeheads at an aquaculture facility during an earlier state visit to North Korea and wanted to introduce them to Madagascar as a personal project. A shipment of *C. maculata* was made from China to Ratsiraka in 1976. The shipment was divided equally with one group stocked into ponds at the presidential summer residence near Antananarivo, situated in the upper reaches of the northwestward-flowing Betsiboka River. The remaining fish were released into ponds at Ratsiraka's family home near Vatomandry on the east coast. Flooding from monsoon rains washed snakeheads out of ponds in both localities and into adjacent natural waters.

By 1986 *Channa maculata* was well established in floodplain lakes of the Betsiboka basin. It has since been recorded from and has become ubiquitous on the western slope between the mouths of the Sofia, Mahajamba, Kamoro, Mahavavy du Sud, Tsiribihina, Moronodava, and Onilahy rivers. As the floodplains of the Mahavavy du Sud, Betsiboka, Kamoro, Mahajamba, and Sofia rivers are often contiguous during exceptionally rainy years, human intervention need not be invoked to account for northward and southward dispersal of this snakehead from the lower reaches of the Betsiboka basin. Although headwater tributaries of the Betsiboka and Tsiribihina rise in relative proximity to one another, presence of this species in Lac Itasy by 1978 (Raminosoa, 1987) is most likely explained by headwater transfer, but could have resulted from human transfer. That lake is drained by the Tsiribihina River which flows to the west-southwest. Translocation by humans is the most logical explanation for presence of *C. maculata* in the Morondava and Onilahy basins, whose headwaters and mouths are separated by formidable physiographic barriers in the first instance and several hundred kilometers of extremely arid terrain in the second.

Distribution of *Channa maculata* along the eastern slope of Madagascar is also discontinuous. Progeny of snakeheads washed from the ponds stocked at Vatomandry were recorded in 1986 from ponds at the Parc Zoologique d'Ivoloina, near the eastern port city of Toamasina, approximately 200 km north of Vatomandry, and in 1998 from the Mangoro basin, some 75 km to the south. Toamasina is located at the northern end of the Pangalanes Canal system that extends some 375 km southward along Madagascar's east coast connecting a series of inland lakes and coastal lagoons. *Channa maculata* is now established in all of the basins between the Ivoloina and Mangoro rivers. It is uncertain if this range expansion was solely by natural dispersal through the canal, whether it was aided by human translocations, or both. Distribution of *C. maculata* south of the Mangoro River is highly discontinuous. It has not been recorded from the Mananjary and Namorona river basins, but specimens have been captured inland from the towns of Farafangana and Vangaindrano, respectively located 650 km and 800 km south of the mouth of the Mangoro. Local residents attribute the presence of this snakehead to activities of Sino-Malagasy merchants in the early 1990s.

North of Toamasina, *Channa maculata* is present in all coastal drainages between the Ivoloina and the Marimbona rivers, including the Manigory which constitutes the outflow of Farihy Alaotra, Madagascar's largest lake. Data are lacking for the drainages situated between the Marimbona and Antainambalana rivers. North of the Masoala Peninsula, *C. maculata* is established in the Ankavia-Ankavanana, Lokoho, Sambava, Bemarivo, Maha-

Table 1. Frequency distribution of fin ray counts in species of *Channa* from Hawai'i

Pectoral fin rays

Species	16	17	18	19	N	Mean
Channa argus	-	2	5	1	8	17.8
Channa maculata	3	8	-	-	11	16.7
Channa striata	1	2	2	-	5	17.2

Dorsal fin rays

Species	40	41	42	43	44	45	46	47	48	49	50	51	52	N	Mean
Channa argus	-	-	-	-	-	-	-	-	1	2	3	1	1	8	49.9
Channa maculata	-	-	2	3	2	3	1	-	-	-	-	-	-	11	43.8
Channa striata	1	-	4	-	-	-	-	-	-	-	-	-	-	5	41.6

Anal fin rays

Species	25	26	27	28	29	30	31	32	33	N	Mean
Channa argus	-	-	-	-	-	-	2	1	5	8	32.4
Channa maculata	-	-	1	3	5	1	-	-	1	11	29
Channa striata	1	2	2	-	-	-	-	-	-	5	26.2

Table 2. Frequency distribution of scale counts in species of *Channa* from Hawai'i

Lateral line scales

Species	54	55	56	57	58	59	60	61	62	63	64	65	66	N	Mean
Channa argus	-	-	-	-	-	-	-	1	1	2	1	1	2	8	63.8
Channa maculata	1	-	2	5	2	1	-	-	-	-	-	-	-	11	56.9
Channa striata	1	2	2	-	-	-	-	-	-	-	-	-	-	5	55.2

Scales above lateral line

Species	4	5	6	7	8	9	N	Mean
Channa argus	-	-	-	1	6	1	8	8
Channa maculata	-	10	1	-	-	-	11	5.1
Channa striata	5	-	-	-	-	-	5	4

Scales below lateral line

Species	10	11	12	13	14	15	16	17	18	19	N	Mean
Channa argus	-	-	-	-	-	2	1	2	2	1	8	16.9
Channa maculata	-	-	1	4	6	-	-	-	-	-	11	13.5
Channa striata	3	2	-	-	-	-	-	-	-	-	5	10.4

Caudal peduncle scales

Species	24	25	26	27	28	29	N	Mean
Channa argus	-	-	-	2	3	2	7	28
Channa maculata	3	5	1	-	-	-	9	24.8
Channa striata	-	2	1	2	-	-	5	26

Cheek scales

Species	9	10	11	12	13	14	N	Mean
Channa argus	-	-	-	1	2	5	8	13.5
Channa maculata	-	-	2	4	3	-	9	12.1
Channa striata	3	2	-	-	-	-	5	9.4

Rows of interorbital scales

Species	3	4	5	6	N	Mean
Channa argus	-	-	5	3	8	5.4
Channa maculata	-	-	10	1	11	5.1
Channa striata	5	-	-	-	5	3

nara, Fanambana, and Menambery basins. Residents of the towns of Antalaha and Sambava attribute establishment of the snakehead in northeastern Madagascar to Sino-Malagasy merchants who brought fingerlings from Antananarivo in the late 1990s. Comparable oral testimony is lacking for drainages between the Ivoloina and Marimbona, but *C. maculata* was established in Lake Aloatra by 1985 (Raminosoa, 1995) and may well have dispersed into this region via the Manigory River. Headwaters of all these rivers are separated by significant physiographic barriers, while their mouths lie neither in a seasonally flooded coastal plain nor are they linked by anything comparable to the Pangalanes Canal. Human intervention is thus the most plausible mechanism for establishment of *C. maculata* north of the Ivoloina basin.

Some species of snakeheads are difficult to identify due to similarities in meristic characters and color patterns. However, there are significant meristic characters that can be used to separate *Channa maculata* from *C. striata* (Tables 1, 2). Among them are the number of anal fin rays (Table 1), scales above and below the lateral line, cheek scales, and rows of interorbital scales (Table 2). Also, as Figs. 1–4 indicate, it is not difficult to identify these two species utilizing only color pattern differences. For snakeheads in general, there have been few ichthyologists working with their taxonomy. In addition, *C. striata* almost certainly represents a species complex (Courtenay & Williams, in press).

Discussion

Jordan & Evermann were apparently unfamiliar with *Channa maculata*. They described a snakehead from Taiwan (Jordan & Evermann, 1902b) as *Ophicephalus tadianus*, now recognized as a synonym of *C. maculata* (Okada, 1961). Furthermore, they seemed unfamiliar with *C. striata* when they misidentified the introduced population of *C. maculata* in Hawai‘i as that species (Jordan & Evermann, 1905). Also puzzling is that they failed to recognize the snakehead species in Hawai‘i as the same fish they described from Taiwan as *O. tadianus* (Jordan & Evermann, 1902b).

Some species of snakeheads are capable of overland migrations as adults (Lee & Ng, 1991). *Channa maculata* is not one of those species, except as juveniles, but *C. striata* is (Peter Ng, pers. comm., 2002). A resident of Madagascar reported observing juvenile *C. maculata* slithering onto land, allowing themselves to become covered with ants, then returning to the water where the ants floated at the surface, to be devoured by the young snakeheads.

Recent land development on O‘ahu has resulted in replacement of ponds and rice paddies, managed during the 1800s and early 1900s by Asian immigrants. Those ponds and paddies also served as habitat for *Channa maculata*, now confined primarily to Wahiawā Reservoir and some smaller impoundments of northern O‘ahu (Yamamoto & Tagawa, 2000).

Importation of *Channa striata* to Hawai‘i is recent. A permit to import *C. maculata* from Thailand was issued to Arlo W. Fast of the University of Hawai‘i in the early 1990s (Domingo Cravalho, pers. comm., 2003), and the stock was received in May 1994 (Qui & Fast, 1996a). The species was imported for aquaculture research purposes, conducted at the Hawai‘i Institute of Marine Biology on Coconut Island (Qui & Fast, 1996a). The permit to import *C. striata* may have been granted believing the species was already established in Hawaiian waters. Following a few years of research, experimental stock was later released to the Hawai‘i Seafood Company for aquaculture purposes. No recent permits

have been issued for importation of snakeheads to Hawai‘i (Domingo Cravalho, pers. comm., 2003), and importation into the U.S. and exportation to other states of live snakeheads is now prohibited by Federal Regulation (67 FR 62193).

Hawai‘i is geologically recent, formed by a series of volcanic uplifts from the Pacific floor. The oldest extant island appears to be about 5 million years old (McDowall, 2003). The Hawaiian freshwater fish fauna is depauperate and consists of five species of gobies, four of which are endemic to the island group (Yamamoto & Tagawa, 2000; McDowall, 2003). Each belongs to separate genera that are found elsewhere in the Pacific and some also in the Indian Ocean. These fishes are amphidromous, requiring access to the ocean for larvae to undergo a period of growth before reentry into freshwater streams to complete their life histories. Because native Hawaiian freshwater fishes live primarily in streams, contact with introduced *Channa maculata* is minimal. Other inland waters (canals, reservoirs) where *C. maculata* exists are typically not frequented by native freshwater fishes, and are dominated by 40 or more introduced fish species, several of which, like *C. maculata*, are predators (Yamamoto & Tagawa, 2000).

In contrast, Madagascar is a fragment of the southern super continent of Gondwana, an island that has been isolated from Africa for about 100 million years and broke away from the proto-Indian subcontinent some 65 million years ago or more (Loiselle, 1995). Madagascar hosts a speciose freshwater fish fauna of extraordinary scientific interest (Reinthal & Stiassny, 1991; Stiassny, 2002; Raminosoa *et al.,* 2002). Representatives of 46 genera of fishes attributable to 23 families have been reported from fresh waters of Madagascar. Two families, catfishes of the family Anchariidae and Madagascar rainbowfishes (Bedotiidae), are endemic. Madagascar is home to 14 endemic genera and one genus, *Pachypanchax*, found only on the island and the neighboring Seychelles Islands, another set of Gondwanan fragments. One hundred three (74%) of the 140 species recorded from interior waters of Madagascar are endemic. Of these, only 13 share the amphidromic pattern of the endemic gobies of Hawai‘i. The remaining 90 species are restricted to fresh waters (Raminosoa *et al*., 2002). That the nearest relatives of all but one of Madagascar’s endemic genera occur in India or Australasia rather than the African mainland (Stiassny & Pinna, 1994) affords some measure of antiquity of these lineages.

The Malagasy ichthyofauna is also characterized by an extreme degree of endangerment. Extinction of four species has been documented since the late 1950s. Using criteria established by the International Union for the Conservation of Nature, 23 species are considered critically endangered, 34 endangered, and 20 vulnerable. The major recognized threats to these fishes are habitat degradation due to ongoing deforestation, and predation by and/or competition from nonindigenous fishes of which 24 out of the 28 species introduced have become established (Reinthal & Stiassny, 1991). *Channa maculata* (then identified as *Ophicephalus striatus*) has been implicated in displacement of the endemic cichlid genus *Paratilapia*, formerly Madagascar’s most widespread cichlid, from the central highlands and Lake Aloatra (Raminosoa, 1987, 1995; Lévêque, 1997). Testimony of local residents strongly suggest that the rapid and largely human-assisted dispersal of *C. maculata* into rivers and streams on both slopes of the island in recent years poses a significant threat to many other species of native Malagasy freshwater fishes. This threat has been recognized and recommendations made to prevent additional introductions, and halt further secondary translocations of established invasive exotics such as the snakehead (Raminosoa *et al*., 2002). Moreover, *C. maculata* may present a threat to native amphibians. In the central highlands, the only aquatic predators experienced historically by frog

tadpoles were native eels (Anguillidae). Those same waters now contain this introduced snakehead.

Misidentification of introduced *Channa maculata* in both Hawai‘i and Madagascar raised the possibility that some other reports of introduced populations of *C. striata* (*e.g*., Mauritius and some islands of Oceania; Welcomme, 1981, 1988; Parameswaran & Goorah, 1981; Lever, 1996) may be *C. maculata*. The illustration of the snakehead in Parasmewaran & Goorah (1981) is that of *C. maculata*, not *C. striata*. Identification of *C. striata*, introduced during the 1970s or 1980s and established on the Vogelkop Peninsula, Papua, Indonesia (Allen, 1991), has been confirmed as correct by photographs supplied by Gerald R. Allen (pers. comm., 2002).

Finally, we hope this contribution emphasizes the importance of both accurate identification of introduced species by taxonomic specialists and the continuing need for deposition of voucher specimens in research museums. Realistic predictions of how nonindigenous species might or might not be capable of altering habitats or ecosystems cannot be made unless the species in question has been identified accurately. Information available on ecology of introduced species within their native ranges cannot be accessed without a correct identification, nor can information be exchanged on their performance in an alien environment with taxonomists and ecologists working where they have been introduced previously.

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