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Distribution, Osteology, and Natural History of the Asian Giant Softshell Turtle, *Pelochelys bibroni*, in Papua New Guinea

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ABSTRACT. – **The Asian giant softshell turtle, *Pelochelys bibroni* (Cryptodira: Trionychidae), is distributed widely from southeast Asia to the island of New Guinea. In Papua New Guinea it occurs in two apparently disjunct populations in the northern and southern lowlands. This report extends the known distribution eastwards in the northern lowlands, augments the known distribution in the southern lowlands, and describes differences in osteology and color pattern between the two geographic isolates. Preliminary findings also suggest that the southern New Guinean population is different from southeast Asian populations of *P. bibroni*, and may represent a new and undescribed species. Notes on habitat, natural history, reproduction, body size, human utilization, and vernacular names are also presented.**

The Asian giant softshell turtle *Pelochelys bibroni* (Testudines: Trionychidae) is an extremely wide-ranging species, distributed from eastern peninsular India across most of southeast Asia to southern China and Hainan Island, as well as from the Malaysian peninsula across the Indonesian archipelago and the Philippines to the island of New Guinea (Pritchard, 1979; Das, 1985; Ernst and Barbour, 1989; Das, 1991). On New Guinea it has been recorded from both Irian Jaya and Papua New Guinea, where until recently it was known only from the southern regions of the island. The geographic distribution as documented by museum specimens has recently been presented by Iverson (1986, 1992). Osteological morphology of the species including its neural bone configuration has been analyzed by Meylan (1987), who studied most Trionychidae and made significant contributions to the understanding of the phylogenetic relationships of the family.

No previous analysis exists of the distribution, habitat, osteology, morphology, and natural history of *Pelochelys bibroni* in New Guinea. In this report we document significant range extensions for the species in northern Papua New Guinea and augment the number of documented localities in southern Papua New Guinea. Also, we describe noteworthy geographic variation in the osteology of its neural bone configuration as compared to Asian *P. bibroni*. In addition, we document morphological differences in carapacial color pattern between the geographic isolates of the species from northern and southern Papua New Guinea, and provide notes on habitat, natural history, reproduction, body size, and vernacular names. We further provide a summary and overview of the literature on the species, especially as regards Papua New Guinea.

Interestingly, despite the widespread distribution of the species from the Malaysian peninsula to New Guinea there are no documented localities for *P. bibroni* anywhere between Borneo and New Guinea itself. Whereas it has been recorded from Sumatra and Java, it is unreported from a large section of the Indonesian archipelago that includes Sulawesi, the Lesser Sundas, Halmahera, and the Moluccas. Whether the relatively small size and lack of major freshwater rivers on many of those islands constitutes the reason for *P. bibroni*'s apparent absence remains unknown. Sulawesi appears to have suitable habitat available, and *P. bibroni* may have been present there at some point in the past, if not still. Sub-fossil archaeological remains of *Chitra indica* have been found there (Whitten et al., 1987) and some of these could possibly represent misidentified *P. bibroni*.

Human Utilization

In areas of its range where this species is common it often constitutes a significant portion of the turtle diet of the local inhabitants. Das (1991) reports that large numbers are killed for consumption in the northern parts of Orissa in India. Ahmad (1955) documents its occasional presence in food markets of East Pakistan (Bangladesh), and Khan (1987) indicates that it is uncommon in Bangladesh, but readily eaten when available, with the flesh being considered tasty. Cantor (1847) noted that in Malaysia in the mid-nineteenth century it was frequently taken in fishing stakes along the coast in Penang and that the Chinese greatly relished it as food.

In Papua New Guinea *Pelochelys bibroni* is a potentially economically important species. Although scarce and often difficult to capture, this large species is avidly sought by fishermen and usually consumed or sold for meat in local village markets when caught (Waite, 1903; Jones, 1950; Zweifel, 1973). The large amount of meat available from each animal makes it an important addition to the subsistence diet of the local inhabitants (Liem and Haines, 1977; Liem, 1983). In addition to the meat, its bony carapace is prized by Sepik River villagers who use it to make elabo-

Figure 1. Ceremonial artifact masks of *Pelochelys bibroni* from the Sepik River basin, northern Papua New Guinea. *Left*: Yamandin, Karawari River; *Right*: Yentchen, Sepik River; see Fig. 5 for radiograph of this specimen. Photos by R.A. Mittermeier.

rately decorated ceremonial masks, many of which are subsequently sold through a thriving primitive artifact trade (Fig. 1). The large size and relative scarcity of the species make *Pelochelys* masks significantly more sought after (and expensive) than the much more common and smaller masks made from shells of the chelid turtle *Elseya novaeguineae*. These two are the only freshwater turtle species occurring in the Sepik River drainage and are the only ones used for Sepik ceremonial masks. Many of these ceremonial masks are sold in the Sepik basin and also brought to major centers throughout Papua New Guinea for sale to tourists. Large artifact supply stores in Port Moresby often have large numbers of turtle ceremonial masks for sale. We have traveled extensively through native villages and visited numerous artifact centers throughout Papua New Guinea, and though we have seen hundreds of *Elseya novaeguineae* ceremonial masks, we have encountered only three made from *Pelochelys bibroni*.

Cox (1984) reports that the ratio of *E. novaeguineae* to *P. bibroni* specimens encountered in the Ambunti area of the middle Sepik is about 500 to 1, and R. Perron (*pers. comm.*) notes that inhabitants of Angoram in the lower Sepik feel that *P. bibroni* has become rare in recent years where it used to be quite common some 50 years earlier. Whether commercial pressure from the ceremonial mask trade or subsistence fishing efforts have caused this reported decline of *P. bibroni* in the Sepik basin remains totally unknown. Parker (1981) listed *P. bibroni*, *Carettochelys insculpta* and the marine turtles as "Restricted Species" in terms of export from Papua New Guinea, whereas none of the more common chelid turtles were restricted at that time.

Body Size

Pelochelys bibroni is the largest freshwater turtle in New Guinea, approached in size only by the Fly River turtle *Carettochelys insculpta*. In the Asian portion of its range, *P. bibroni* has been recorded as reaching phenomenal sizes. Ernst and Barbour (1989) record its maximum carapace length as up to 129 cm (based on a specimen measured by De Rooij, 1915). Das (1985) reports that a specimen from Vietnam measured 200 cm in overall length (head and neck plus carapace), and Constable (1982) records another Vietnamese specimen at approximately 5.5 feet overall body length (= 165 cm) and allegedly weighing 550 lbs (= 250 kg) when alive. In Thailand, Nutaphand (1979) records specimens of up to 100 cm carapace length and 85 kg body weight, while Mell (1922) notes a Chinese specimen of 72 cm carapace length weighing 27 kg. Pope (1935) records a specimen from Hainan of 56 cm carapace length weighing 42 lbs (= 19 kg), noting also that Hainanese fishermen felt that typical adults weighed about three times that amount, or about 57 kg. Taylor (1921) noted that specimens on Luzon Island in the Philippines grow to more than 100 cm carapace length. Cantor (1847) measured a Malaysian specimen (as *Gymnopus indicus*) of 37 inches carapace length (= 93 cm).

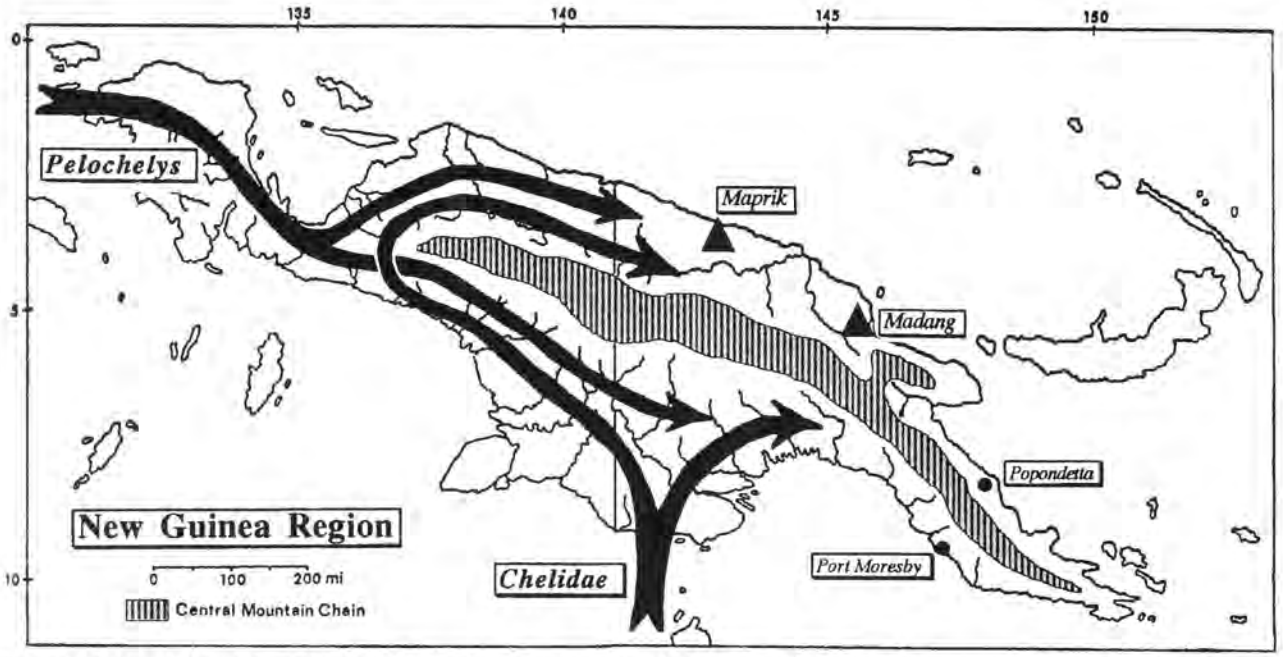

Figure 2. Map of New Guinea Region showing hypothesized invasion routes of *Pelochelys* from Asia and Chelidae from Australia. Localities plotted are: Maprik, the previous easterly range record for *Pelochelys bibroni* in northern Papua New Guinea; Madang, the range extension for *P. bibroni* reported in this paper; Popondetta, the easterly range record for *Elseya novaeguineae* in northern Papua New Guinea; and Port Moresby, the approximate easterly range record for *P. bibroni* and Chelidae in southern Papua New Guinea.

In New Guinea, recorded sizes of specimens encountered are similar in range to the Asian records, though not quite matching their extraordinary size. The first specimen of *P. bibroni* recorded from Papua New Guinea (Laloki River) by Waite (1903) measured 65 cm carapace length and weighed 68 lbs (= 31 kg). Jones (1950) recorded a second Laloki River specimen measuring 3 feet (=90 cm). R. Perron (*pers. comm.*) has measured a Sepik specimen at 55 cm carapace length. We have examined a Lake Murray specimen of 77 cm carapace length, and one from Komovai, Fly River measuring 102 cm carapace length. Other New Guinea specimens we have examined have all been significantly smaller. These measurements are of total carapace length, which includes the extensive soft posterior portion of the shell. Elsewhere in the literature, especially in osteological descriptions, carapace length sometimes refers to only the bony portion of the carapace, thereby sometimes confusing the issue of size in this species.

Distribution

The northern and southern lowlands of New Guinea are separated by formidable mountain ranges that form the spine of the island. These mountain ranges serve as effective barriers to the north-south distribution of freshwater turtles except in the western portions of Irian Jaya, where the mountains are lower and offer less significant barriers to north-south dispersal. Presumably as a result of this wide barrier, most freshwater turtles in New Guinea are restricted to the southern lowlands of the island. Among the sideneck turtles (Chelidae) of Australian origin, five species of *Chelodina* (*C. novaeguineae, C. parkeri, C. siebenrocki, C. reimanni,* and *C. sp. nov.* [Rhodin, in press]) as well as *Emydura subglobosa* are all restricted to the southern drainages, as is the cryptodiran *Carettochelys insculpta*. The only chelid turtle that has a more or less cosmopolitan distribution in New Guinea and is also found in the northern drainages of the island is *Elseya novaeguineae* (*sensu lato*), whose northern and southern populations are actually different closely-related species (Rhodin and McCord, in prep.). Access to the northern regions by *E. novaeguineae* appears to have been via the low-lying areas just south of the Geelvink Bay area in western Irian Jaya, with subsequent spread eastwards along the northern half of the island, reaching as far as Popondetta, Northern Province, Papua New Guinea. Whether an area of intergradation or sympatry between the southern and northern forms of *Elseya novaeguineae* (*sensu lato*) occurs anywhere in the areas south of Geelvink Bay remains unknown.

The only other freshwater turtle to have invaded the northern half of New Guinea is the Asian giant softshell turtle *Pelochelys bibroni*. As opposed to *Elseya*, which appears to have originated in Australia, *P. bibroni* is Asiatic in origin and probably spread eastwards along both the southern and northern halves of the island (Fig. 2). Most records for *P. bibroni* in New Guinea have been from the southern drainages, with Waite (1903) being the first to record its presence on the island based on a large gravid female collected in the Laloki River near Port Moresby, Central Province, Papua New Guinea. Other records of the presence of *P. bibroni* in southern New Guinea are given by Boulenger (1914), De Rooij (1915, 1917), Jones (1950), Rhodin and Mittermeier (1976), Liem (1977), Rhodin and Rhodin (1977), Liem and Haines (1977), Whitaker et al. (1982), and Liem (1983). Only three published records exist for the presence of *P. bibroni* in northern New Guinea.

of the bony carapace and the carapacial color pattern of living specimens. We have not examined any skulls, and the following notes do not constitute a full osteological description of the species. In addition, taxonomic analysis through morphological investigations of the two disjunct geographic forms of *P. bibroni* in Papua New Guinea is currently in progress by R.G. Webb (*pers. comm.*, and In prep.), and any systematic conclusions await his results.

The specimen of *P. bibroni* collected at Madang is a carapace measuring 21.3 cm in midline straight length of the bony disc and is currently preserved as AGJR-T 836 (personal collection of Rhodin, eventually to be deposited at the MCZ). Aside from its noteworthy locality as the easternmost record of northern New Guinean *P. bibroni*, the specimen also exhibits the most anterior location of neural bone reversal yet recorded for the species *P. bibroni* or most members of the family Trionychidae (Fig. 4). Neural bone reversal is defined as that point along the neural bone series where the orientation of the neural bones switches from posteriorly-directed hexagons to anteriorly-directed hexagons. This position is marked by either a smaller intercalated rectangular neural (see radiograph of ceremonial mask of *P. bibroni* in Fig. 5) or two irregularly shaped pentagons, one posteriorly directed, the other anteriorly directed (Fig. 4). Meylan (1987) examined 223 specimens of trionychids of 18 different species and found that neural position 5 was the most anterior location recorded for neural bone reversal in any trionychid that he examined. Pritchard (1988) examined neural bones in 2 specimens of *P. bibroni* and 28 other trionychids and found a few specimens of *Trionyx ferox* (= *Apalone ferox*) with a bewildering variety of neural configurations including more anterior neural reversals at positions 2/3, 3, 3/4, 4, and 4/5. Our specimen of *P. bibroni* from Madang has neural reversal at position 4/5 (Fig. 4), one step further anterior than previously recorded for *P. bibroni*. We follow Meylan's neural bone terminology where the single fused element between the first pair of pleural bones is counted as neurals 1 and 2. Meylan (1987) recorded variation in *P. bibroni* neural reversal based on examination of 10 specimens (only 1 from New Guinea), and found all to have reversals posterior to position 4/5. His data in Table 6 on page 20 of his 1987 paper appear to indicate neural position 5/6 as being the most anterior and position 6/7 as being the modal location for reversal in *P. bibroni*. Re-examination of Meylan's original data sheets indicates that an unfortunate typographic error occurred in the transposition of his data for publication. Many of his *P. bibroni* data in Table 6 (Meylan, 1987) were transposed into the wrong column, and in fact, for 9 of his 10 specimens the real location of neural bone reversal was actually one step further anterior than published. Therefore, instead of neural position 6/7 representing the modal condition of 0.50 incidence, that modal number should be recorded as neural position 6, and the most anteriorly recorded position of neural reversal is actually at position 5 instead of 5/6.

We have since obtained data on an additional 19 specimens of *P. bibroni* from various portions of its range, giving a study sample of 29 animals (9 from New Guinea and 20 from Asia, including Hainan Island). Our results indicate that most New Guinean specimens of *P. bibroni* have the position of their neural bone reversal located more anteriorly (modal position 5/6) than in the mainland Asiatic stock (modal position 6).

We examined eight (of nine) specimens of New Guinean *P. bibroni* and found the modal location of neural reversal at position 5/6, one step further anterior than the modal condition for 19 (of 20) Asiatic specimens at position 6. In addition, all 9 New Guinean specimens have 9 neurals (8 discrete bony elements, the fused first neural counting as 2), whereas 7 of 20 Asiatic specimens have 8 neurals (7

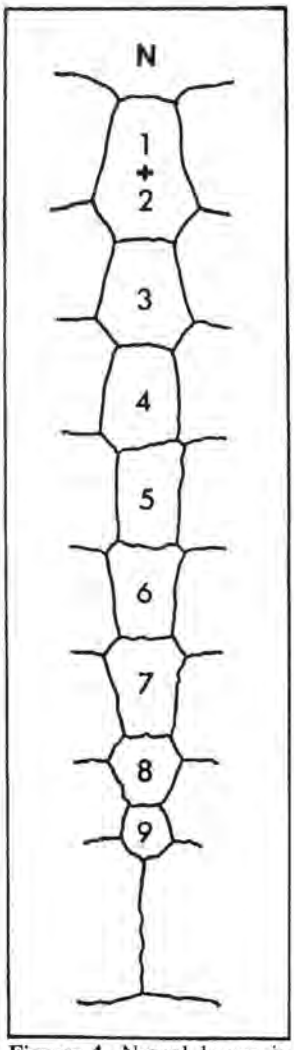

Figure 4. Neural bones in *Pelochelys bibroni* (AGJR-T 836) from the Gogol River, Madang Province, Papua New Guinea, showing neural bone reversal at position 4/5. N = nuchal bone, neurals 1 and 2 fused (neural counting method of Meylan, 1987).

Table 1. Number of neural bones and location of reversal in neural bone orientation in *Pelochelys bibroni* of different origins. Fused neurals 1 and 2 count as two neurals as per Meylan (1987). Location of neural reversal not visible in 1 specimen from Asia, 1 from northern New Guinea.

Origin	*n*	*# Neurals*			*Location of neural reversal*					
		7	8	9	4/5	5	5/6	6	6/7	7
Asia	20	1	7	12	0	2	4	9	1	3
New Guinea	9	0	0	9	1	0	5	2	0	0
(North NG)	6	0	0	6	1	0	2	2	0	0
(South NG)	3	0	0	3	0	0	3	0	0	0

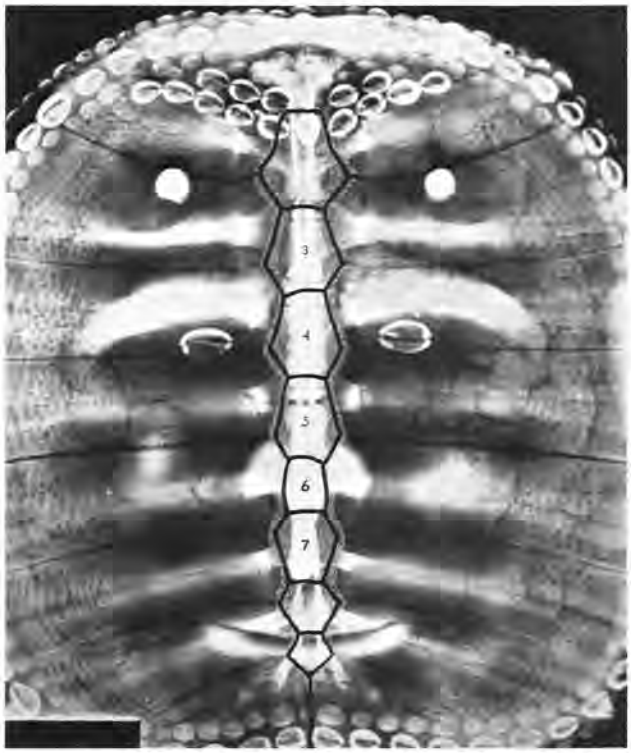

Figure 5. Radiograph of *Pelochelys bibroni* (AGJR-T 1782) decorated ceremonial mask (see Fig. 1) from Yentchen, Sepik River, Papua New Guinea, showing neural bone reversal as intercalated rectangular neural at position 6, *sensu* Meylan (1987). Neural bone sutures highlighted for clarity.

discrete bony elements), and one Asiatic specimen has 7 neurals (6 elements), with the rest, 12 of 20, having the same number of neural bones as the New Guinean sample (9 neurals, 8 elements). See Tables 1 and 2 as well as Figure 6 for a graphic depiction and summary of these findings. As a basis for comparison, the results for New Guinean and Asiatic *P. bibroni* have been plotted as if they represent separate taxa, with an additional breakdown for southern vs. northern New Guinean *P. bibroni*. Other trionychids examined for comparative purposes include the two taxa most closely related to *P. bibroni* according to Meylan (1987), *Chitra indica* and *Amyda cartilaginea,* as well as the somewhat more distantly related *Pelodiscus sinensis*. Of note is that each of these species, including the New Guinean and Asiatic forms of *P. bibroni*, has a different modal location for neural bone reversal, with New Guinean *P. bibroni* at 5/6, Asian *P. bibroni* at 6, *C. indica* at 6/7, *A. cartilaginea* at 7, and *P. sinensis* at 7/8 (see Figure 6). We detect no evidence of difference in neural reversal when comparing northern and southern New Guinean forms of *P. bibroni*.

Meylan (1987) hypothesizes that the anterior migration of neural bone reversal represents a derived condition for trionychid turtles, with the primitive condition being either more posteriorly located or no reversal at all. Whether the apparent further anterior migration of neural reversal in New Guinean as compared to Asiatic *P. bibroni* has any taxonomic or functional significance remains unknown (see Pritchard, 1988, for further discussion). By itself it does not constitute sufficient reason for the recognition of New Guinean *P. bibroni* as a separate species from Asiatic *P. bibroni*, but it suggests potential taxonomic distinctness, and further studies are needed.

Color Pattern

No systematic study of the geographic variation of *Pelochelys bibroni* throughout its vast range has ever been undertaken, although R.G. Webb (*pers. comm.*, and In prep.) has performed a preliminary examination of morphological characteristics and believes the southern New Guinean form of *P. bibroni* may represent a new taxon, separate from the northern New Guinean form which he considers more similar, though perhaps distinct from, the mainland Asiatic form. We detect no evidence of difference in neural bone reversal pattern between the northern and southern forms of New

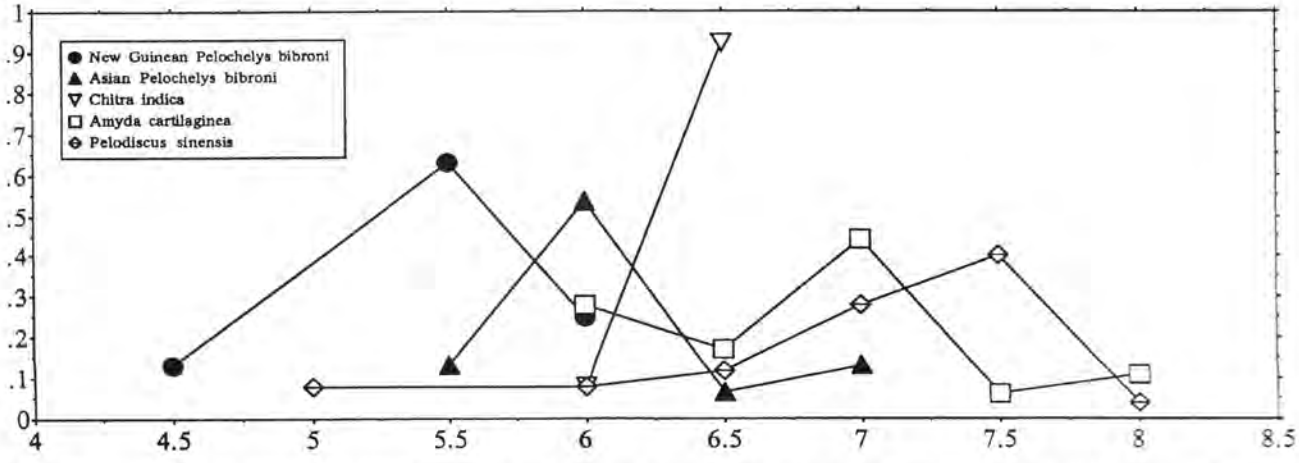

Figure 6. Location of reversal in neural bone orientation (from posteriorly-directed to anteriorly-directed hexagons) in 5 taxa of Australasian Trionychidae, expressed as the frequency of occurrence (y-axis) at each location (x-axis). Locations 5, 6, 7, 8 indicate occurrence as a rectangle at the corresponding neural bone, locations 4.5, 5.5, etc. indicate occurrence as two pentagons straddling the corresponding neural bones (4/5, 5/6, etc.). The graph demonstrates that each "taxon" (including the two geographic isolates of *Pelochelys bibroni*) has its own modal location of neural bone reversal: New Guinean *P. bibroni* at 5/6, Asian *P. bibroni* at 6, *Chitra indica* at 6/7, *Amyda cartilaginea* at 7, and *Pelochelys sinensis* at 7/8. See Table 2 for supporting data.

Table 2. Frequency of location of neural bone orientation reversal in 5 "taxa" of Australasian Trionychidae, indicating modal position in bold print (see Figure 6 for graphic presentation). Data from *Pelochelys bibroni* from present study and Meylan, 1987, data from *Chitra indica, Amyda cartilaginea,* and *Pelodiscus sinensis* from Meylan, 1987.

Taxon	*n*	*modal location*	*frequency of location of neural reversal*							
			4/5	5	5/6	6	6/7	7	7/8	8
New Guinea *P. bibroni*	8	5/6	.13		**.63**	.25				
Asian *P. bibroni*	19	6		.11	.21	**.47**	.05	.16		
C. indica	13	6/7				.08	**.92**			
A. cartilaginea	18	7				.22	.17	**.44**	.06	.11
P. sinensis	25	7/8		.08		.08	.12	.28	**.40**	.04

Guinean *P. bibroni*, but there are definite differences in carapacial color patterns between these two forms.

Southern New Guinean adult specimens of *P. bibroni* we have examined have beautiful, strikingly patterned dorsal shells with irregularly radiating bold stripes of light yellow-brown on a dark brown background covering the central bony portions of the carapace (Fig. 7A), superficially very similar to the pattern seen in the giant Asian narrow-headed softshell *Chitra indica*. The soft carapacial margin has a marbled pattern of smaller yellow-brown reticulations and spots. Some of the bold light yellow-brown anterior carapacial stripes extend further forward as thinner lines onto the dorsal surface of the neck and head (Fig. 7B), but do not quite form the typical "V" that characterizes the pattern in *Chitra indica*. Northern New Guinean juvenile specimens of *P. bibroni* we have examined have a uniform olive-gray color without any significant carapacial pattern except for numerous small, random, dark olive-brown dots (Figs. 8A, 8B). Adult northern specimens we have seen have a uniformly gray carapace without any significantly discernible color pattern. The possibility of sexual dimorphism or ontogenetic variation needs to be investigated as the cause of these apparent geographic differences in color pattern, but in our opinion, taxonomic distinctness is the more likely explanation.

We have not examined live Asiatic specimens of *P. bibroni*, but the preserved specimens we have seen are all similar to the northern New Guinean form, with relatively featureless gray or dark carapaces. Previous descriptions in the literature of color pattern of Asiatic *P. bibroni* confirm these observations. Gray (1864) describes juvenile Philippine specimens as "head olive, minutely black-dotted". Taylor (1921, 1970) describes adult Philippine specimens as "head above olive, with minute black dots; carapace olive, with a few darker and lighter striations along the the median dorsal part; outer edge olive, with small spots of darker or lighter color", providing a photograph of an adult with no significant pattern (Taylor, 1970; p.151). De Rooij (1915) describes Indonesian specimens as uniform olive or brown or spotted with dark brown. Pope (1935) describes Chinese specimens as dark olive with inconspicuous dark dots on the upper surface of the head. Smith (1931) and Bourret (1941) describe southeast Asian specimens as olive with numerous yellow spots. Nutaphand (1979) describes Thailand juvenile

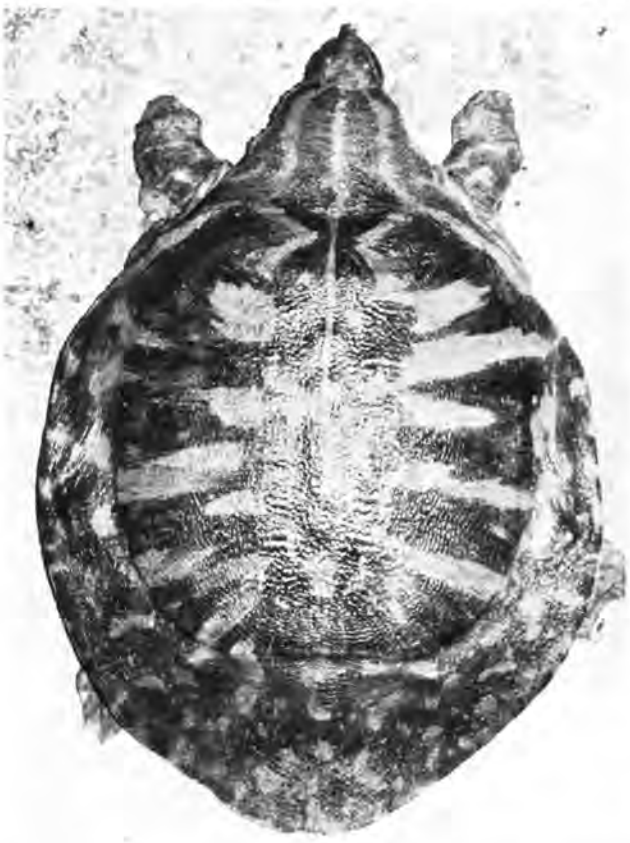

Figure 7A. Live specimen of southern New Guinean *Pelochelys bibroni*; adult female (77 cm CL) from Lake Murray, Western Province (AGJR-P 353). Photo by A.G.J. Rhodin.

Figure 7B. Live specimen of southern New Guinean *Pelochelys bibroni*; adult from Lake Murray, Western Province (AGJR-P 353); close-up of head. Photo by A.G.J. Rhodin.

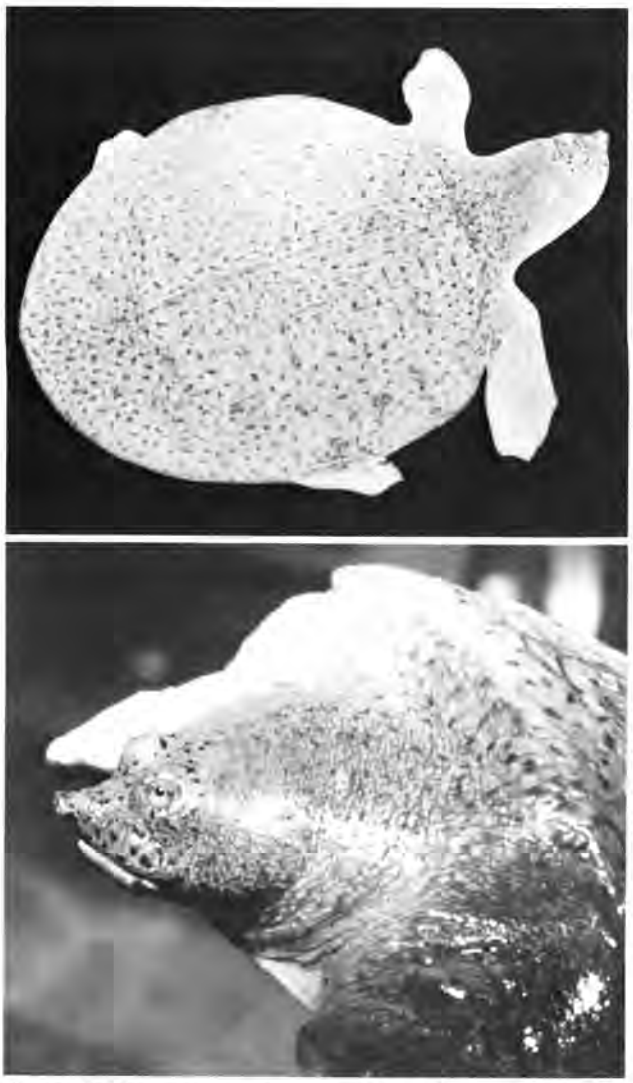

Figure 8. Live specimen of northern New Guinean *Pelochelys bibroni*. A. juvenile from Maprik, East Sepik Province (AGJR-P 354); B. close-up of head of same animal. Photos by A.G.J. Rhodin.

specimens as leaf-green with yellow spots all over, adult specimens deep olive with head and neck olive gray. Das (1985) describes Indian specimens as unpatterned olive, dotted with yellow. Günther (1864, plate 6C) has described and figured a *Chitra indica* with a broad vermiculate pattern that Gray (1864) and Smith (1931) synonymized under *Pelochelys*, but these determinations are suspect.

In view of the marked superficial resemblance between southern New Guinean *P. bibroni* and *Chitra indica*, confirmation of the identification of the species by analysis of skull morphology is required. Two skulls of *Pelochelys bibroni* collected by Hall in the Western Province of Papua New Guinea have been examined by R.G. Webb (*pers. comm.*, and In prep.) and are definitely typical *Pelochelys*.

Natural History

Few data are available on ecological parameters of *P. bibroni* in Papua New Guinea. We have obtained some information on natural history and reproduction through the work of Hall in the Lake Murray and Fly River region of the Western Province in 1981. We now present these data and review the information previously available in the literature.

Little is known about nesting and reproduction. Ernst and Barbour (1989) cite Mell (1929) who states that 27 eggs represent a typical clutch for *P. bibroni*, but that a full complement of eggs is not deposited at one time. This information is based on the original report by Waite (1903) who dissected a large gravid female he collected in the Laloki River, Port Moresby, Papua New Guinea. He reported that the animal was collected on 3 September, weighed 68 lbs with a carapace length of 65 cm, and that the ovaries contained eggs in all stages of development while the oviducts held 27 completely shelled, perfectly smooth white eggs whose dimensions averaged 34.5 x 33.3 mm and 30.9 gm. Based on this information, the nesting season would appear to be in September in the Port Moresby region, this being the dry season. Cox (1984) reported finding three nearly full-term clutches of *P. bibroni* in a freshwater crocodile (*Crocodylus novaeguineae*) nest mound on 10 October 1981 in the Ambunti area of the middle Sepik River, Papua New Guinea. This also suggests September in the dry season as the nesting period in the Sepik basin. It is also the first known record of nesting commensalism between *Pelochelys bibroni* and *Crocodylus novaeguineae*.

According to natives interviewed by Hall in the Lake Murray and upper Fly River region nesting by *P. bibroni* there also occurs during the dry season, primarily in September. This information was obtained in several native villages and appears reliable, though in one village (Komovai, Fly River) information was given that nesting occurs slightly earlier during the dry season, from June through August. Nesting is said to occur along the mud flats of the major rivers in the area, specifically the Fly, Strickland, Herbert, and Kaim Rivers. No nesting is known to occur along the large lagoons, grass swamps, and smaller creeks in the area. The only other turtle species that shares nesting sites with *P. bibroni* in New Guinea is *Carettochelys insculpta*, which nests communally in the mud flats along the same major rivers during the same time period. The smaller chelid turtles in the area, *Chelodina novaeguineae, C. parkeri, Emydura subglobosa*, and *Elseya novaeguineae,* all nest near the lagoons, swamps, and smaller creeks, and are not known to nest along the large rivers. Clutch size for *P. bibroni* is reported by villagers as being approximately the same as for *Carettochelys insculpta*, which they variably report as being 22-24, 20-35, and 30-45. In one village (Bosset, upper Fly River) clutch size for *P. bibroni* was reported as being greater than 100. Egg size of *P. bibroni* is reported as being slightly smaller than for *Carettochelys insculpta*.

Comparative reproductive data for Asian *P. bibroni* are relatively meager. Moll (*in* Ernst and Barbour, 1989) reports that in Malaysia the nesting season is February and March, with clutch size 24-28, and the spherical eggs averaging 35 mm in diameter. Das (1985) reports that in India the species nests in December, sometimes more than once a season, and that 20-28 eggs of 30 mm diameter are laid.

Whether the reported clutch size of greater than 100 eggs for *P. bibroni* at one locality on the Fly River is accurate or not is not known, but the closely related and similar-sized giant narrow-headed softshell turtle *Chitra indica* has been recorded as producing clutches of similar size. Nutaphand (1979) describes a specimen from Thailand of 111 cm carapace length weighing 108 kg that laid a clutch of 107 shelled eggs in captivity, with the eggs measuring 34 mm in diameter and weighing 20 gm each. The animal died shortly thereafter and on dissection was found to contain an additional 450 unshelled eggs and ovarian follicles, including 210 of 20 mm diameter, 100 of 12 mm diameter, and more than 140 of smaller diameter. It would not be surprising for similarly-sized *P. bibroni* to also be capable of producing clutches of this magnitude. Clutch size may be correlated with body size, in which case larger *P. bibroni* would produce larger clutches.

Despite the large size, even adult *P. bibroni* are not immune to predation. Hall records the find of a 4.6 m saltwater crocodile (*Crocodylus porosus*) captured by Usokof villagers at the mouth of the Kaim River in Lake Murray during January 1981 that was found to have an adult *Pelochelys* in its stomach. Jones (1950) has also reported that the two species of crocodiles that occur in New Guinea (*C. porosus* and *C. novaeguineae*) constitute the only known natural predators of adults of the species.

Vernacular Names

Vernacular names of *P. bibroni* from some localities in New Guinea have previously been recorded by Rhodin and Spring (1979) and Rhodin et al. (1980). The names that we have previously recorded are *labi-labi* in Bahasa Indonesian in Irian Jaya, *kenwa* from Manokwari in Irian Jaya (Delsman 1951), and *mamuruwo gamo* from Tureture, Western Province, Papua New Guinea.

We now provide additional names obtained by Hall in 1981 in the Lake Murray and upper Fly River region of the Western Province, Papua New Guinea. Hall records the following vernacular names based on village interviews: *memene*, used at Kaviananga, Komovai, Wangawanga, Bosset, Manda, Mipan, and Boikumava, upper Fly River above the Strickland River junction; *bombaro*, used at Kuem, Agu River, upper Fly River; *fa*, used at Kusikina, Miwa, Egiza, and Magipopo, along the shores of Lake Murray and the Herbert River; *momu*, used at Kapikam, Kaim River, northeast of Lake Murray; and *elewuse*, used at Upovia, north of Lake Murray.

Systematics

Five separate nominal taxa are currently included in the genus *Pelochelys*. These are *Trionyx (Gymnopus) bibroni* Owen, 1853, type-locality "Australia" [presumably in error, possibly representing a specimen of southern New Guinean origin having been obtained via Australia, but more likely a mis-labeled Asian specimen (R.G. Webb, *pers. comm.*)]; *Pelochelys cantorii* Gray, 1864, type-locality "Malacca, marine" [peninsular Malaysia]; *Pelochelys cumingii* Gray, 1864, type-locality "Philippines"; *Pelochelys poljakowii* Strauch, 1890, type-locality Fu-Tschau [China]; and *Pelochelys taihuensis* Zhang, 1984, type-locality "Tongxiang County, Zhejiang" [China]. All of these taxa are usually synonymized under *P. bibroni*, although *P. taihuensis* has yet to be done so formally (P.A. Meylan, *pers. comm.*).

Clearly, a detailed study of the variation of external and skeletal morphology of *P. bibroni* throughout its vast range is desirable. The apparent absence of *P. bibroni* from the large mid-Indonesian archipelago region of "Wallacea" (Sulawesi, the lesser Sundas, Halmahera, and the Moluccas) suggests a potentially long period of isolation of the New Guinean population from the Asiatic mainland and Borneo - Philippines portion of the range. Whether the New Guinean populations of *P. bibroni* have undergone sufficient evolutionary change from the mainland Asiatic stock to warrant taxonomic distinctness is open to question, as is the possibility that there may well be two separate and distinct taxa of *Pelochelys* on the island of New Guinea. Our preliminary results suggest that at least the southern New Guinean form of *Pelochelys bibroni* may be specifically distinct from the Asian populations, and that distinction may also exist between the northern New Guinean and Asian forms. R.G. Webb (In prep.) has initiated a study to investigate this in greater depth, and we await his analysis.

Conservation Status

The overall conservation status of *Pelochelys bibroni* in Papua New Guinea remains unknown. It would appear to be naturally rare, highly exploited when encountered, and possibly vulnerable or even seriously depleted as a result. The IUCN/SSC Tortoise and Freshwater Turtle Specialist Group has categorized *P. bibroni* as a widespread species believed to be in need of some conservation action and it has received Action Plan Rating 3 (Stubbs, 1989). However, if the New Guinean population is recognized as specifically distinct, then APR category 2 for a species with restricted distribution might be more appropriate. More detailed studies regarding the distribution, abundance, population status, and exploitative pressures on *P. bibroni*, both for ceremonial masks and subsistence diet, would be beneficial in formulating a rational and directed conservation effort for this large freshwater turtle species.

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Specimens Examined

We examined 7 New Guinean specimens, included data from an eighth specimen from Waite (1903), and from a ninth specimen photographed by R. Perron in which neural bones were visible and countable, as well as photographic documentation of additional specimens provided by J. Lang and the authors. In addition to AGJR-T 836 from the Gogol River in Madang, we also examined carapaces of AGJR-T 873, 1522, and 1782 from the Sepik River basin, Papua New Guinea; PNGM 23438 from the Brown River, Central Province, Papua New Guinea; and MCZ 153921 from Maprik, East Sepik Province, Papua New Guinea. One of Meylan's (1987) specimens whose data sheet we re-examined (USNM 231523) was from Balimo, Western Province, Papua New Guinea. Asiatic material examined include 6 specimen data sheets of Meylan's originally examined specimens from Thailand, Borneo, Sumatra, and India (BMNH 1947.3.6.21 [type of *Pelochelys cantorii*], 80.4.25.6, 99.1.12.7, 1974.2330, NHMB 183, NMW 1857, EOM 2675), 8 specimens from the personal collection of Pritchard originating from Hainan, China, and Penang, Malaysia (PCHP 2375-6, 2648, 2908-10, 2921, 3229), and 2 specimens from the MCZ collection from Thailand (MCZ 29489-90). In addition, 3 of Meylan's examined specimens (BMNH 64.9.28.5, 87.3.30.15, and 1 [no number]) with no data are probably Asiatic in origin, with 8, 7, and 9 neural bones respectively, with corresponding neural reversals at locations 5/6, 6, and 7. One Asiatic specimen recorded by Bourret (1941) showing neural bones was also included in the study sample. Acronyms for museum locations of specimens examined or documented in this paper are as follows: AMNH, American Museum of Natural History; BMNH, British Museum of Natural History; AMS, Australian Museum, Sydney; LSUMZ, Louisiana State University Museum of Zoology; MCZ, Museum of Comparative Zoology; NHMB, Naturhistorisches Museum, Basel; NMW, Naturhistorisches Museum Wien; PNGM, Papua New Guinea Museum; USNM, United States National Museum; EOM, personal collection of Edward O. Moll; PCHP, personal collection of Peter C.H. Pritchard; AGJR-T, personal collection of Rhodin, constituting either preserved specimens, voucher photographs, or reliably documented data.

LITERATURE CITED and GENERAL BIBLIOGRAPHY of *Pelochelys bibroni*

Ahmad, Nazir. 1955. On edible tortoises and turtles of East Pakistan. Dacca: Government of East Bengal Directorate of Fisheries, 18 pp.

Baur, Georg. 1891. Note on the trionychian genus *Pelochelys*. Ann. Mag. Nat. Hist. (6)7:445-446.

Boulenger, George A. 1889. Catalogue of the Chelonians, Rhynchocephalians, and Crocodiles in the British Museum (Natural History). London: Trustees of the Museum, 311 pp.

Boulenger, George A. 1890. The Fauna of British India, including Ceylon and Burma. Reptilia and Batrachia. London: Taylor and Francis, 541 pp.

Boulenger, George A. 1891. On the occurrence of *Pelochelys* in China. Ann. Mag. Nat. Hist. (6)7:283-284.

Boulenger, George A. 1914. An annotated list of the batrachians and reptiles collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea. Trans. Zool. Soc. Lond. 20(5):252-253.

Bourret, René. 1941. Les tortues de l'Indochine. Station Maritime de Cauda, Annam, 235 pp.

Cantor, Theodore. 1847. Catalogue of reptiles inhabiting the Malayan peninsula and islands. J. Asiatic Soc. Bengal 16:607-656, 897-952, 1026-1078.

Constable, John D. 1982. Visit to Vietnam. Oryx 16(3):249-254.

Cox, Jack. 1984. Crocodile nesting ecology in Papua New Guinea. Livestock Div., Dept. Prim. Indust., FAO, UN, Port Moresby, DP/PNG/74/029, Field Document No. 5, 203 pp.

Das, Indraneil. 1985. Indian Turtles - A Field Guide. Calcutta: World Wildlife Fund, 119 pp.

Das, Indraneil. 1986. A survey of the batagur turtle of the Sunderbans with notes on other reptiles. Hamadryad 11(3):3-8.

Das, Indraneil. 1991. Colour Guide to the Turtles and Tortoises of the Indian Subcontinent. Avon, England: R & A Publishing, 133 pp.

Delsman, H.C. 1951. Dierenleven in Indonesie. Den Haag: W. van Hoeve.

De Rooij, Nelly. 1915. The Reptiles of the Indo-Australian Archipelago. I. Lacertilia, Chelonia, Emydosauria. Leiden: E.J. Brill, 334 pp.

De Rooij, Nelly. 1917. Nova Guinea. Resultats de l'expedition scientifique neerlandaise a la Nouvelle-Guinee. Reptiles (Lacertilia, Chelonia and Emydosauria). Leiden: E.J. Brill, Vol.13, Zoologie (2):133-153.

Elter, O. 1982. Cataloghi V. La collezione erpetologica del Museo di Zoologia dell'Universita di Torino. Torino: Mus. Region. Sci. Nat., 116 pp.

Ernst, Carl H. and Roger W. Barbour. 1989. Turtles of the World. Washington: Smithsonian Inst. Press, 313 pp.

Fang, P.W. 1930. Notes on chelonians of Kwangsi, China. Sinensia 1(8):95-135.

Fang, P.W. 1934. Notes on some chelonians of China. Sinensia 4(7):145-200.

Frair, Wayne. 1985. The enigmatic plateless river turtle, *Carettochelys*, in serologic survey. J. Herpetol. 19(4):515-523.

Gaffney, Eugene S. 1979. Comparative cranial morphology of recent and fossil turtles. Bull. Amer. Mus. Nat. Hist. 164:65-376.

Girgis, Sabet. 1961. Observations on the heart in the family Trionychidae. Bull. Brit. Mus. Nat. Hist. Zool. 8:73-107.

Gray, John E. 1864. Revision of the species of Trionychidae found in Asia and Africa, with the descriptions of some new species. Proc. Zool. Soc. London 1864:76-98.

Günther, Albert C.L.G. 1864. Reptiles of British India. London: The Ray Society, 452 pp.

Iverson, John B. 1986. A Checklist with Distribution Maps of the Turtles of the World. Privately Printed, Richmond, Indiana, 283 pp.

Iverson, John B. 1992. A Revised Checklist with Distribution Maps of the Turtles of the World. Privately Printed, Richmond, Indiana, 363 pp.

Jerdon, T.C. 1853. Catalogue of reptiles inhabiting the peninsula of India. J. Asiat. Soc. Bengal 22:462-479.

Jones, Lawrence. 1950. Giant freshwater turtle from Papua. Proc. Roy. Zool. Soc. New South Wales 1948-49:37-38.

Kar, C.S. and R.J. Rao. 1985. A gharial (*Gavialis gangeticus*)

at the Gahirmatha coast, Orissa, India. J. Bombay Nat. Hist. Soc. 82(3):671-674.
Khan, M.A.R. 1987. Bangladesher Bonnyoprani. Vol. I. Dhaka, Bangladesh: Bangla Academy, 169 pp.
King, F. Wayne and Russell L. Burke. 1989. Crocodilian, Tuatara, and Turtle Species of the World. A Taxonomic and Geographic Reference. Washington, DC: Association of Systematics Collections, 216 pp.
Liem, David S. 1977. Important wildlife species of the Tonda wildlife management area of the Western Province. Wildl. Papua New Guinea 77(20):1-7.
Liem, David S. and A.K. Haines. 1977. The ecological significance and economic importance of the mangrove and estuarine communities of the Gulf Province, Papua New Guinea. In: Petr, T. (Ed.). Purari River (Wabo) Hydroelectric Scheme Environmental Studies, Vol. 3, pp.1-35. Waigani, Papua New Guinea: Office of Environment and Conservation.
Liem, David S. 1983. Survey and management of wildlife resources along the Purari River. In: Petr, T. (Ed.). The Purari - Tropical Environment of a High Rainfall River Basin. The Hague: Dr. W. Junk, pp. 269-282.
Mell, R. 1922. Beitrage zur Fauna sinica. I. Die Vertebraten Sudchinas; Feldlisten und Feldnoten der Sauger, Vogel, Reptilien, Batrachier. Arch. Naturgesch. 88A(10):1-134.
Mell, R. 1929. Beiträge zur Fauna sinica. IV. Gründzuge einer Ökologie der chinesischen Reptilien und einer herpetologischen Tiergeographie Chinas. Berlin, 282 pp.
Meylan, Peter A. 1987. The phylogenetic relationships of soft-shelled turtles (family Trionychidae). Bull. Amer. Mus. Nat. Hist. 186:1-101.
Moll, Edward O. and J. Vijaya. 1986. Distributional records for some Indian turtles. J. Bombay Nat. Hist. Soc. 83:57-62.
Nair, P.N. Radhakrishan and M. Badrudeen. 1975. On the occurrence of the soft-shell turtle, *Pelochelys bibroni* (Owen), in marine environment. Indian J. Fish 22:270-274.
Nutaphand, Wirot. 1979. The Turtles of Thailand. Bangkok: Siamfarm Zoological Garden, 222 pp.
Ouwens, P.A. 1914. List of Dutch East Indian chelonians in the Buitenzorg Zoological Museum. Contrib. Faune Ind. Neerl. Buitenzorg 1:29-32.
Owen, Richard. 1853. Descriptive catalogue of the osteological series contained in the Museum of the Royal College of Surgeons of England. Vol I. Pisces, Reptilia, Aves, Marsupialia. London: Taylor and Francis.
Parker, Fred. 1981. Collecting, export, import, research and filming involving wildlife in Papua New Guinea. Wildlife Pap. New Guinea Wildl. Publ. 81(2):1-58.
Petocz, Ronald G. 1989. Conservation and Development in Irian Jaya: A Strategy for Rational Resource Utilization. Leiden: E.J. Brill, 218 pp.
Pope, Clifford H. 1929. Notes on reptiles from Fukien and other Chinese Provinces. Bull. Amer. Mus. Nat. Hist. 58:335-487.
Pope, Clifford H. 1934. List of Chinese turtles, crocodilians, and snakes, with keys. Amer. Mus. Novitates 733:1-29.
Pope, Clifford H. 1935. The Reptiles of China. New York: American Museum of Natural History, 604 pp.
Pritchard, Peter C.H. 1979. Encyclopedia of Turtles. Hong Kong: TFH Publ., 895 pp.
Pritchard, Peter C.H. 1988. A survey of neural bone variation among recent chelonian species, with functional interpretations. Acta Zool. Cracov. 31:625-686.
Rashid, S. M. A. and Ian R. Swingland. 1990. Interim report on the freshwater turtle trade in Bangladesh. Asiatic Herp. Res. 3:123-128.
Rhodin, Anders G.J. and Russell A. Mittermeier. 1976. *Chelodina parkeri*, a new species of chelid turtle from New Guinea, with a discussion of *Chelodina siebenrocki* Werner, 1901. Bull. Mus. Comp. Zool. 147(11):465-488.
Rhodin, Anders G.J. and Susan DeSanctis Rhodin. 1977. Iakttagelser från en herpetologisk samlingsresa till Papua New Guinea. (Observations from a herpetological collecting trip to Papua New Guinea.). Snoken - Nat. Swed. Herp. Assoc. 7(2/3):65-72.
Rhodin, Anders G.J. and Sylvia Spring. 1979. Vernacular names of turtles in the New Guinea area. Wildl. Papua New Guinea 79(3):1-16.
Rhodin, Anders G.J., Sylvia Spring, and Peter C.H. Pritchard. 1980. Glossary of turtle vernacular names used in the New Guinea region. J. Polynesian Soc. 89(1):105-117.
Rhodin, Anders G.J. In press. Chelid turtles of the Australasian archipelago: I. A new species of *Chelodina* from southeastern Papua New Guinea. Breviora.
Schmidt, Karl P. 1927. The reptiles of Hainan. Bull. Amer. Mus. Nat. Hist. 54:395-465.
Smedley, Norman. 1932. Notes on the herpetological collections in the Selangor Museum. Bull. Raffles Mus. Singapore 7:9-17.
Smith, Malcolm A. 1930. The Reptilia and Amphibia of the Malay Peninsula. Bull. Raffles Mus. Singapore 3:1-149.
Smith, Malcolm A. 1931. The fauna of British India, including Ceylon and Burma. Reptilia and amphibia. Vol. I. Loricata, Testudines. London: Taylor and Francis.
Strauch, A. 1890. Bemerkungen uber die Schildkrötensammlung im Zoologischen Museum. Mem. Ac. St. Petersb. (7)38:1-127.
Strong, Thomas R. 1984. Biogeography of the New Guinea herpetofauna. J. North. Ohio Assoc. Herpetol. 10(1):1-17.
Stubbs, David. 1989. Tortoises and freshwater turtles. An action plan for their conservation. IUCN/SSC Tortoise and Freshwater Turtle Specialist Group, 48 pp.
Taylor, Edward H. 1921. Amphibians and Turtles of the Philippine Islands. Bureau Sci. Manila Publ. 15:1-188.
Taylor, Edward H. 1970. The turtles and crocodiles of Thailand and adjacent waters with synoptic herpetological bibliography. Univ. Kansas Sci. Bull. 49:87-179.
Vijaya, J. 1982. *Pelochelys bibroni* from Gahirmata Coast, Orissa. Hamadryad 7(3):17.
Waite, Edgar R. 1903. A fresh-water turtle (*Pelochelys cantoris*, Gray), from New Guinea. Rec. Austral. Mus. 5:50-52.
Webb, Robert G. In prep. Two species of giant softshell turtle (*Pelochelys*) in New Guinea.
Whitaker, Rom, Zai Whitaker, and Dave Mills. 1982. Reptiles of Papua New Guinea. Wildl. Papua New Guinea 82(2):1-53.
Whitten, Anthony J. , Muslimin Mustafa, and Gregory S. Henderson. 1987. The Ecology of Sulawesi. Yogyakarta, Indonesia: Gadjah Mda University Press, 777 pp.
Williams, Ernest E. 1950. Variation and selection in the cervical central articulations of living turtles. Bull. Amer. Mus. Nat. Hist. 94:510-561.
Zhang, Minghua. 1984. A new species of *Pelochelys* from Zhejiang, with subfossil description. Acta Herpetol. Sin. 3(4):71-76.
Zweifel, Richard G. 1973. Reptiles and amphibians. Aust. Nat. Hist. 17(12):434-439.