

Carinotetraodon salivator, a New Species of Pufferfish from Sarawak, Malaysia (Teleostei: Tetraodontidae)

Kelvin K. P. Lim¹ and Maurice Kottelat²

¹Zoological Reference Collection, Department of Zoology, National University of Singapore, Kent Ridge, Singapore 0511

²Case postale 57, 2952 Cornol, Switzerland

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Abstract *Carinotetraodon salivator*, a new species of freshwater pufferfish, is described from Sarawak. It differs from its only known congener, *C. lorteti*, in having a shallower body (depth 36–41% SL, vs. 45–53), 10 anal fin rays (vs. 11), 16–17 pectoral fin rays (vs. 14–15), 17–18 (mode 18) vertebrae (vs. 15–17, mode 16), eyes situated nearer the dorsal profile of the head, a distinct pale blotch present under the lower lip, a white distal margin absent from the caudal fin, and a ventrum which is striped in females and cross-banded in mature males. A lectotype is designated for *Tetraodon borneensis* Regan, 1902.

The genus *Carinotetraodon* was first erected by Benl (1957) to accommodate *C. chlupatyi* Benl, 1957, presently considered a junior synonym of *C. lorteti* (Tirant, 1885) (see Dekkers, 1975: 97; Kottelat, 1986). *Carinotetraodon* is distinguished from other genera of Tetraodontidae by having mid-dorsal and mid-ventral skin folds or ridges present in males, being most obvious in live specimens. Other characters include the laterally compressed body and the sexually dimorphic colouration and colour pattern of adults. Females exhibit a complicated reticulated dark brown and whitish pattern, while mature males assume a distinctly different colour pattern, especially evident when in breeding condition. Dekkers (1975), in his review of Asiatic freshwater pufferfishes, considered *Carinotetraodon* as a synonym of *Tetraodon* but failed to provide any discussion of his generic synonymy. Following Tyler (1978, 1980: 312) and Kottelat et al. (1993), the genus *Carinotetraodon* is recognised as valid.

In July, 1992, we collected a freshwater pufferfish in the vicinity of Kuching, Sarawak (Malaysia), which, due to the presence of a dorsal ridge, the sexually dimorphic colouration and the colour pattern of the female clearly belongs to the genus *Carinotetraodon*. However, it differs from *C. lorteti* in many respects, and is here described as a new species.

Material and Methods

Measurements follow the method of Dekkers (1975). The length of the caudal peduncle was measured point to point from the base of the last anal ray to the posterior end of the hypural plate; the depth was measured at the narrowest point. Geographical coordinates of the material collected by us have been obtained by GPS. Examined specimens are from the following collections: BMNH, Natural History Museum, London; SM, Sarawak Museum, Kuching; USNM, National Museum of Natural History, Washington; ZRC, Zoological Reference Collection, National University of Singapore; ZSM, Zoologische Staatssammlung, Munich, and CMK, the second author's collection.

Carinotetraodon salivator sp. nov. (Figs. 1–3)

Holotype. ZRC 37465, male, 30.4 mm SL (Fig. 1); Borneo: Sarawak: Sungai Bejit, km 10 on road to Simunjan after it branches from Kuching-Sri Aman road (1°08'39"N, 110°53'43"E); M. Kottelat and K. Lim, 2 July 1992.

Paratypes. All material from Borneo: Sarawak. ZRC 37466–37471, 6 ex., SM uncat., 5 ex.—CMK 8393, 5 ex., 14.3–40.0 mm SL; same data as holotype.—ZRC 37831,

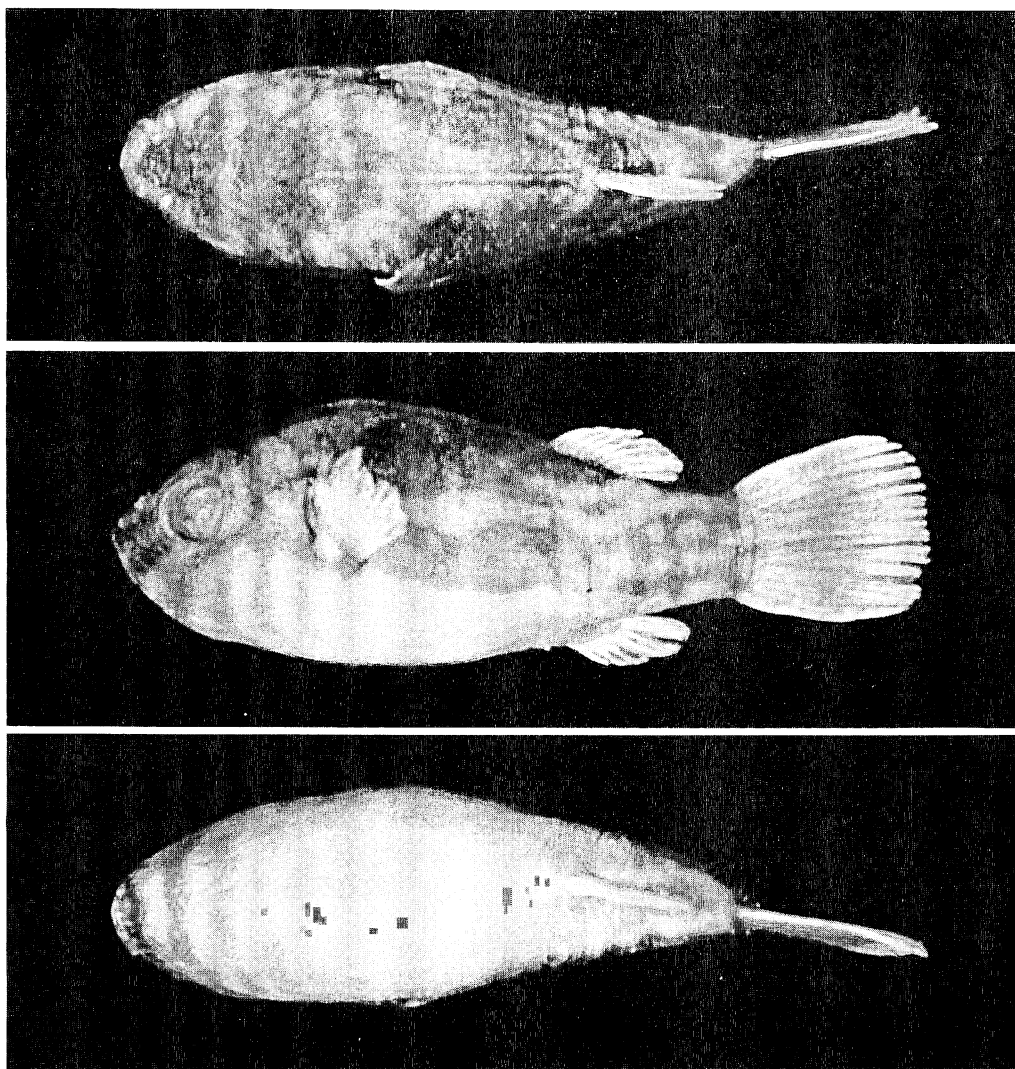


Fig. 1. *Carinotetraodon salivator*, ZRC 37465, holotype, male, 30.4 mm SL; dorsal, lateral and ventral aspects.

2 ex.—SM uncat., 2 ex.—CMK 10883, 2 ex., 18.9–24.1 mm SL; Sungai Nibong, about 1 km north of Durin ferry on road from Sarikei to Sibu ($2^{\circ}09'53.0''\text{N}$, $112^{\circ}00'59''\text{E}$); M. Kottelat et al., 7 and 15 May 1994.—CMK 10930, 1 ex., 24.2 mm SL; Sungai Isu, km 20 on road to Simunjan after it branches from Kuching-Sri Aman road ($1^{\circ}12'14''\text{N}$, $110^{\circ}55'27''\text{E}$); M. Kottelat and D. Chung, 11 May 1994.—USNM 322184, 2 ex., 31.7–33.9 mm SL; Baleh River, creek entering south bank, about 20 km east of Sut River; L. Parenti, Mohd. Zakaria-Ismail and K. Luhath, 24 July 1991.—USNM 322187, 2 ex., 23.7–27.8 mm SL; Kapit River just south of where it enters the Rajang River ($01^{\circ}59'\text{N}$, $112^{\circ}55'\text{E}$); L. Parenti, 27 July 1991.—USNM 322186, 2 ex., 34.1–36.2 mm SL; Baleh River, tributary flowing into main part of river opposite Sekolah Negara Bawai

($02^{\circ}00'\text{N}$, $113^{\circ}03'\text{E}$); L. Parenti and Mohd. Zakaria-Ismail, 24 July 1991.—USNM 322188, 3 ex., 20.0–24.3 mm SL; Kapit River by Kapit Airport ($01^{\circ}58'\text{N}$, $112^{\circ}55'\text{E}$); L. Parenti and K. Luhath, 29 July 1991.—USNM 323665, 1 ex., 38.8 mm SL; Baleh River, creek entering north bank, about 5 km east of Sut River; L. Parenti, Mohd. Zakaria-Ismail and K. Luhath, 25 July 1991.

Diagnosis. A small pufferfish, with a maximum known standard length of 40.0 mm. It is immediately distinguishable from any other freshwater puffer (and any marine one known to us) by the unique colour pattern of both sexes (see Figs. 1–3). Both sexes have a complex reticulated midlateral stripe

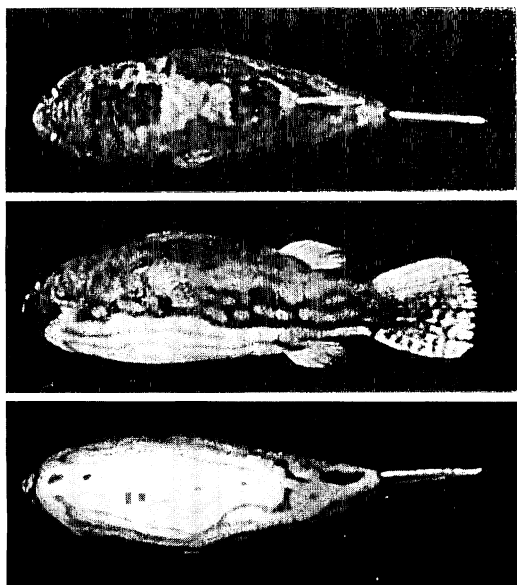


Fig. 2. *Carinotetraodon salivator*, ZRC 37466–37471, paratype, female, 34.2 mm SL; dorsal, lateral and ventral aspects.

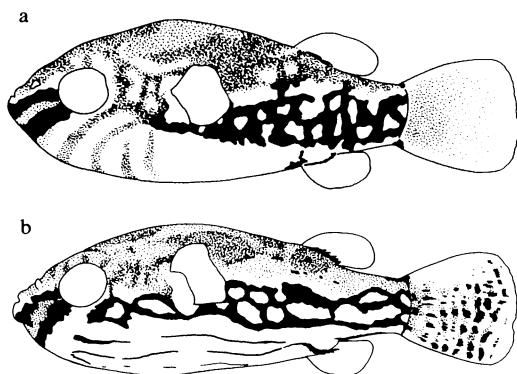


Fig. 3. Colour patterns of specimens of *Carinotetraodon salivator* (schematised). a) Male, holotype, ZRC 37465, 30.4 mm SL; b) female, paratype, ZRC 37466–37471, 34.2 mm SL.

and two dark greyish bands stretching from the anterior lower edge of one eye, across the throat under the lower lip to the other eye. The upper band is deeply indented by a large white patch under the lower lip (Fig. 4). The ventrum is cream-coloured and striped in females, bluish grey (red in life) with 3–5 cross-bars anteriorly in mature males, the posteriormost cross-bar beginning at the pectoral base. Anal fin rays 10, pectoral fin rays 16–17, vertebrae 17–18.

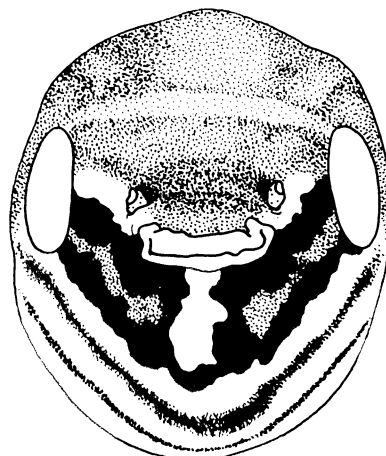


Fig. 4. *Carinotetraodon salivator*, ZRC 37465, holotype, male, 30.4 mm SL; frontal view showing the chin bands (schematised).

Description. Body elongate, oval in lateral view, pointed at the snout tip. Measurements are from the 9 largest specimens, 30.4–40.0 mm SL. Total length 125.3–130.1% SL. Maximum body depth at level of pectoral fin base 36.3–40.7% SL. Maximum body width 31.3–36.9% SL. In cross-section, head is anteriorly cylindrical, compressed slightly from the sides below the eyes. From the dorsal aspect, the body tapers posteriorly to the caudal base, with the widest point at the pectoral region. Dorsal profile arched, highest point at about level of pectoral-fin origin, interorbital slightly convex to flat. Adult males with a narrow mid-dorsal ridge of skin from the interocular region to the dorsal-fin origin. A second, less distinct crest follows the mid-ventrum before the anal-fin origin. Belly convex, protruding most under the base of the pectoral fin. Dorsal-fin origin slightly in advance of anal-fin origin. Lateral line system indistinct, body spines small but dense on back, sides and ventrum.

Head large, length 36.1–39.7% SL. Eyes large, lateral diameter 11.6–13.7% SL, 32–36% HL, positioned slightly below dorsal profile of head, at midpoint between tip of snout and gill opening. Interorbital width 19.5–21.6% SL, 52–59% HL. Mouth terminal, upward directed, lower lip protruding beyond upper lip, chin rather heavy, corner of mouth opening at mid eye-level. Nostril closer to mouth than to eye, tubular, a little higher than broad, with one terminal opening and a slight lobe, marked with dark, sparsely placed pigments (Fig. 5).

Dorsal-fin rays 10 (5) or 11 (4). Predorsal length

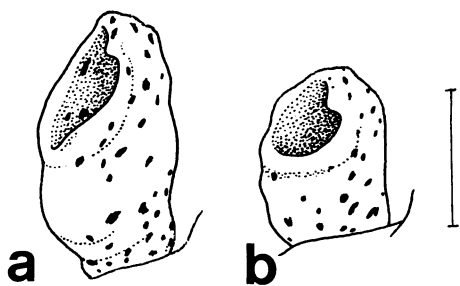


Fig. 5. *Carinotetraodon salivator*, nostril of: a) female, paratype, ZRC 37466–37471, 34.2 mm SL; b) male, holotype, ZRC 37465, 30.4 mm SL. Scale bar: 0.5 mm.

70.6–74.9% SL. Anal-fin rays 10. Preanal length 69.5–76.2% SL. Pectoral-fin rays 16 (7) or 17 (2). Caudal-fin rays 5+6. Caudal peduncle length 21.5–25.2% SL; depth 14.9–17.0% SL, 1.28–1.63 times in its length. Vertebrae 17 (1) or 18 (12).

Colour description. Male, preserved (Figs. 1, 3a). Body and head greyish with complex reticulated or mottled pattern. A pale grey band from eye forward to tip of snout. A narrow pale grey interorbital band. A broad, pale grey chevron-shaped band on back, the extremities contacting upper posterior edge of eye, joining or not ends of interorbital band. Blunt apex of chevron not reaching dorsal origin. A second smaller, narrower pale grey chevron mark with apex in contact with dorsal-fin origin. On the flanks, a broad pale grey band extends from lower posterior edge of eye through gill opening to back of caudal peduncle where it meets its homologue. This band is often interrupted and may have dark brown irregular patterning within. Two or three black undulating stripes extend from eye to caudal-fin base, forming an intricate reticulated pattern, with elements more or less organised into vertical markings. Lips pale grey. Two parallel black bands from anterior lower edge of eye to chin below lower lip, with a pale grey area between them; lower band meets its homologue along ventral midline, while upper band and intermediate grey area are medially interrupted by a conspicuous white patch extending downwards from the edge of the lower lip (Fig. 4). Belly pale, off-white, sharply demarcated from the dorsal ground colour from the lower edge of the gill opening to the base of the caudal peduncle. Behind and parallel to the chin bands, a narrow dark grey bar from the posterior lower edge of the eye, across

the throat to the other eye, followed by 2–4 similar bars, usually continuous across the midventral line; posteriormost bar originating at pectoral-fin base and may be incomplete. Pectoral fin hyaline. Dorsal and anal fins hyaline with black basal blotch. Caudal fin is dusky in small males, but with a faint reticulated pattern in the largest (e.g., USNM 323665, 38.8 mm SL). An elongate dark blotch or short bar on the mid ventrum of the caudal peduncle.

Live male.—The whole fish is bluish grey, with dark brown marks on the flanks. In the largest males, the belly had a broad dark red midventral stripe, becoming more diffuse on the sides.

Female and juvenile, preserved (Figs. 2, 3b).—Head and belly yellowish-brown with darker brown markings. Markings on the back, dorsal and anal fins and chin bands as described above for male. Two or three dark brown undulating stripes from eye to caudal base also form a reticulated or anastomosed pattern, but less intricate than in male. Belly cream coloured, with a single anterior vertical bar (sometimes incomplete or interrupted) parallel to chin bands; 2–8 dark longitudinal stripes (varying in intensity and continuity) on the ventrum begin along this bar and end along ventral midline at level of anal fin base; these stripes may be incomplete, interrupted, somewhat irregular or forming a dendritic pattern in the anal region. Those on the midventrum tend to break up into isolated short stripes or spots. Caudal fin finely reticulated.

Ecological notes. The type locality of *C. salivator* is a large stream about 15 metres wide, the banks of which are lined with shrubs. The clay-covered banks are steeply inclined and laced with exposed tree roots. The depth of the water exceeds two metres, and the bottom is soft and silty at some parts, sandy in others, with leaf litter and submerged logs. A little downstream, where it flows under a road bridge, a short stretch is strewn with large boulders and stones. At this point, the narrowing of the stream creates a riffle with very fast water flow. No information was available on possible tidal influences on water level, flow reversal or flow variation. The pufferfishes were caught by scraping the bottom near the bank on the shaded side with a traynet, especially in places with leaf litter and roots, and from among rocks near the riffle, in depths of about one metre or less. The water in the stream was heavily silted. Syntopic species include *Rasbora cephalotaenia*, *R. cf. sumatrana*, *Homaloptera nebulosa*, *Nemacheilus*

spiniferus, *Hemirhamphodon kuekenthali*, *Doryichthys deokhatoides*, *Eleotris acanthopomus*, *Calamiana* sp. and *Luciocephalus pulcher*. When the locality was revisited on May 13, 1994, the water level was 2–3 m higher due to recent rains and collecting was not possible.

In Sungai Isu, *C. salivator* has been collected in relatively fast flowing, clear water in riffles in the forest (pH 7.0). In Sungai Nibong, it was obtained from a small blackwater stream draining a peat swamp area, with relatively fast flowing, deep (1.5–2 m) water.

Distribution. Specimens are known only from the vicinity of Kuching and the middle and lower Rajang basin in Sarawak (Malaysia), north-western Borneo. We have seen a photograph of a male specimen caught by Joan Cramphorn in the Batang Ai, a tributary of the Lupar (Sarawak).

Etymology. This fish is named *salivator*, meaning “who is salivating,” alluding to the distinct pale blotch on the lower lip, which resembles a drop of saliva. A noun in apposition.

Discussion

Carinotetraodon salivator is easily distinguished from its only congener, *C. lorteti* (Tirant, 1885) by the colouration of both sexes. Live adult male *C. lorteti* have a plain brown body with a red midventral area and red bands on the back and interorbital area; in preserved specimens these red marks may not be retained and the specimen may appear plain chocolate-brown. The conspicuous throat pattern is unique to *C. salivator* (Figs. 1, 3a, 4). The caudal fin of male *C. lorteti* is plain brown or blackish, with a conspicuous white edge, while it is entirely brown or reticulated, without a white margin, in *C. salivator*.

Juvenile and female *C. salivator* are also distinguished by the throat and belly pattern of longitudinal stripes (Figs. 2, 3b); in *C. lorteti*, such stripes are absent, there being, instead, elongated blotches and spots. The reader is referred to the colour photograph of a male *C. lorteti* by A. van den Nieuwenhuisen in van der Vlugt (1968) and Tyler (1978), drawings of both sexes in Tyler (1978) and photographs of both sexes in Kottelat et al. (1993) for comparison.

In both sexes, the pair of chin bands immediately

under the lower lip, with the white blotch interrupting the upper band medially, is unique to *C. salivator* (Fig. 4). In a few cases in *C. lorteti*, there may be a pale blotch under the lower lip, but this is smaller, and never as distinctly marked as in *C. salivator*. The two chin bands are missing in *C. lorteti*.

On the basis of the specimens we examined, the two species could also be distinguished by the number of pectoral-fin rays (16–17 in *C. salivator*, vs. 14–15 in *C. lorteti*), anal-fin rays (10, vs. 11 [10 in a single specimen]), vertebrae (17 [1] or 18 [12], vs. 15 [5], 16 [8] or 17 [5]).

The two species also differ in body and head shape. The body of *C. salivator* is shallower, its depth 36.3–40.7% SL (vs. 45.0–52.5). The greatest body depth is at the level of the pectoral-fin origin (vs. midway between pectoral and dorsal-fin origins). The caudal peduncle is more slender, its depth being 14.9–17.0% SL (vs. 16.8–23.3) and 1.28–1.63 times in its length (vs. 1.02–1.51). From the dorsal aspect, the head of *C. salivator* appears broader (Fig. 6), while *C. lorteti* seems to have a longer snout, but our attempts to quantify this failed to show a numerical difference. In *C. salivator*, the eyes are situated closer to the dorsal profile than in *C. lorteti*.

Carinotetraodon salivator has a denser covering of spines on the body. Although quite difficult to quantify in a way that can be replicated, counts of the total number of spines in an area about equal to the eye size between the eye and the pectoral fin base are ca. 50 in *C. salivator* and ca. 15 in *C. lorteti*.

Carinotetraodon lorteti (Tirant, 1885) was originally described from Viet Nam (Tirant, 1885; Kottelat, 1986). It was subsequently described under a number of synonyms: *Tetraodon borneensis* Regan, 1902, *Tetraodon somphongsi* Klausewitz, 1957, *C. chlupaty* Benl, 1957, *Tetraodon werneri* Benl and Chlupaty, 1957 (a nomen nudum), and *Monotreta tiranti* d'Aubenton and Blanc, 1966. All were synonymised with *C. lorteti* by Dekkers (1975: 97), a synonymy followed here as all nominal species clearly exhibit the colour pattern diagnostic of *C. lorteti* mentioned above and all are missing the elements diagnostic of *C. salivator*. Beside the material of *C. lorteti* examined for the present study and listed below, MK had earlier examined the lectotype, paralectotypes and topotypes of *C. lorteti* (Kottelat, 1986).

Carinotetraodon lorteti is presently known from Thailand, Cambodia, Vietnam, Peninsular Malaysia and Sarawak (North-western Borneo). *Tetraodon*

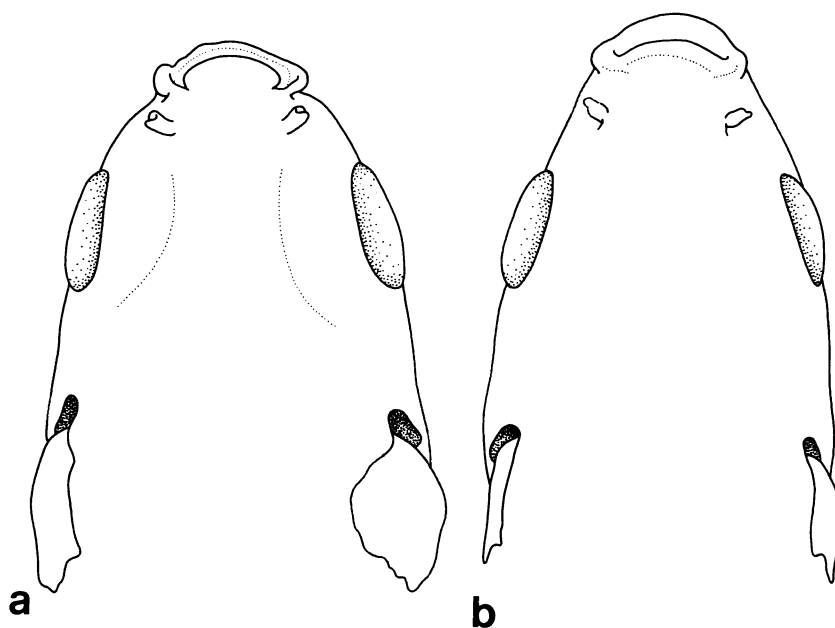


Fig. 6. Dorsal aspect of head of species of *Carinotetraodon*: a) *C. salivator*, female, paratype, ZRC 37466–37471, 34.2 mm SL; b) *C. lorteti*, female, ZSM 22986, 34.2 mm SL.

borneensis Regan, 1902 was described from an unspecified locality in Sarawak on the basis of an unspecified number of specimens, and was regarded as a synonym of *C. lorteti* by Dekkers (1975: 97–101) who examined two syntypes in the BMNH. The original description and illustration (Regan, 1902: pl. 24, fig. 3), as well as de Beaufort's (1962: 398) redescription of *T. borneensis*, are in agreement with our concept of *C. lorteti*. Regan indicated the total length of his largest specimen as 70 mm TL; this seems erroneous as only two specimens are recorded in BMNH registers; they are only 43–44 mm SL (Dekkers, 1975: 99), that is, about 55 mm TL. The illustrated syntype of *T. borneensis* has been examined (BMNH 1894.1.20:16, 43.0 mm SL) and is here designated as the lectotype. It is in agreement with our concept of *C. lorteti* for all the diagnostic characters discussed above (except anal-fin rays). The lectotype is an adult male with very well developed dorsal and ventral keels, and both the original figure and the specimen clearly show the diagnostic colour pattern. The lectotype has 15 pectoral-fin rays, 11 dorsal-fin rays, 10 anal-fin rays; its body depth is 47.0% SL and its caudal peduncle depth is 23.3% SL and 1.16 times in its length.

Carinotetraodon lorteti was also reported from Sarawak (as *C. somphongsi*) by van der Vlugt (1968), but his record was based on aquarium specimens exported from Singapore, although said to have been collected in Sarawak by the exporter.

Su et al. (1986) reviewed biting behaviour in pufferfish species and cited several references of induction of spawning by biting in *C. lorteti*. A single specimen (USNM 322187, 23.7 mm SL) exhibits a large, roundish bite mark in the middle of the left side, slightly in front of the anal and dorsal fins. This specimen is a small male, still with a very weakly developed male colour pattern and it seems unlikely that the bite mark could be attributed to breeding behaviour. None of the other specimens has bite marks.

Comparative Material

Carinotetraodon lorteti: BMNH 1894.1.20:16, 43.0 mm SL, lectotype of *Tetraodon borneensis*; Sarawak; E. Bartlett. —ZSM 15419, 48.4 mm SL, holotype of *C. chlupatyi*; Thailand; aquarium specimen. —ZSM 15420–15421, 2 ex., 38.0–42.9 mm SL; ZSM 22986, 3 ex., 29.1–40.7 mm SL; ZSM 22987, 8 ex., 27.2–35.5 mm SL; Thailand; aquarium specimens.

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サラワクから採集された淡水フグの新種

Kelvin K. P. Lim・Maurice Kottelat

Carinotetraodon 属はこれまで *C. lorteti* のみで構成されていたが、サラワクから採集された標本にもとづいて新種 *Carinotetraodon salivator* を記載した。 *C. salivator* は *C. lorteti* から体高が低い（本種では体長の 36–41% で、 *C. salivator* では 45–53%）、臀鰭条数が 10 本（11 本）、胸鰭条数が 16–17 本（14–15 本）、脊椎骨数 17–18（モードは 18）個（15–17 [モードは 16] 個）、眼が頭部背縁近くに位置する、下唇の下方に明瞭な淡色斑がある、尾鰭後縁が白く縁取られない、腹部に雌では縦線が走り、雄では横帯があることなどの形質で識別される。また、 *Tetraodon borneensis* Regan, 1902 の後模式標本を指定した。