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Two new species of freshwater crabs of the genus *Tiwaripotamon* Bott, 1970 (Crustacea, Decapoda, Brachyura, Potamidae) from northern Vietnam

Van Tu Do*, Tong Cuong Nguyen, Van Dong Dang

Abstract. Two new terrestrial crab species of the family Potamidae, *Tiwaripotamon xuanson* and *T. hamyen*, are described from northern Vietnam. *Tiwaripotamon xuanson* was collected from Xuan Son National Park, Thanh Son district, Phu Tho province, and *T. hamyen* was found in Binh Xa commune, Ham Yen district, Tuyen Quang province. They can be distinguished from other congeners by distinct carapace characteristics and gonopod 1 structures.

Key words. *Tiwaripotamon xuanson*, *Tiwaripotamon hamyen*, taxonomy

INTRODUCTION

Tiwaripotamon Bott, 1970, is a genus of terrestrial crabs living around southwestern China and northern Vietnam. Eight species of this genus have been recorded (sen su Ng et al., 2008; Shih & Do, 2014; Do et al., 2016), including: *T. pingguoense* Dai & Naiyanetr, 1994 and *T. xiurenense* Dai & Naiyanetr, 1994 (in China); *T. araneum* (Rathbun, 1905), *T. annamense* (Balss, 1914), *T. edostilus* Ng & Yeo, 2001, *T. vietnamicum* (Dang & Ho, 2002) and *T. vixuyenense* Shih & Do, 2014 (in Vietnam); and *T. pluviosum* (Do et al., 2016) (in China and Vietnam). It seems to be that each province with limestone mountains in northern Vietnam has their own *Tiwaripotamon* species, such as Ca Bat island of Hai Phong (*T. edostilus*), Ha Giang (*T. vixuyenense*), Ninh Binh (*T. vietnamicum*), Cao Bang (*T. pluviosum*). Indeed, a recent survey by the authors in two other provinces, Tuyen Quang and Phu Tho, obtained two species of this genus that could not be identified as any known species. These new species possess the main characteristics of the genus *Tiwaripotamon* such as the carapace is distinctly broader than long; epigastric and postorbital cristae low, not always distinct; epibranchial tooth is small, distinctly demarcated from external orbital angle. The submedian longitudinal sulcus of third maxilliped is shallow; exopod reaching just beyond the anterior edge of merus, with a short flagellum; ambulatory legs are slender, long, especially merus, propodus, and dactylus (Ng & Yeo, 2001). These two species can be distinguished from its congener by a suite of morphological characteristics. The aim of this study is to describe the two new *Tiwaripotamon* species. Our study brings the total number of species in this genus to 10.

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MATERIAL AND METHODS

Specimens of *Tiwaripotamon* were collected from northern Vietnam (Fig. 1), and were preserved in 70–95% ethanol and illustrated with the help of a drawing tube attached to a stereomicroscope. Materials examined are deposited at Institute of Ecology and Biological Resources (IEBR), Vietnam Academy of Science and Technology (VAST).

The abbreviations G1 and G2 are used for the male first and second gonopods, respectively. Measurements, in millimeters (mm), are of the carapace width (CW), carapace length (CL), as well as the ratio of length/width of the 2th and 4th ambulatory leg. The terminology used here essentially follows that used by Ng (1988) and Ng & Yeo (2001).

TAXONOMY

Family Potamidae Ortmann, 1896

Subfamily Potamiscinae Ortmann, 1896 (sensu Yeo & Ng, 2004)

Genus *Tiwaripotamon* Bott, 1970

Type species: *Geothelphusa annamensis* Balss, 1914, by original designation

Tiwaripotamon xuanson, new species
(Figs. 2–4)

Material examined. Holotype: male (33.1 × 25.6) (IEBR-FC TXx01), 21°7′7.4″N 104°57′7.6″E, Ten Mountain, Xuan Son National Park, Thanh Son district, Phu Tho province, Vietnam, 469 m, coll. V.T. Do, 19 September 2014.

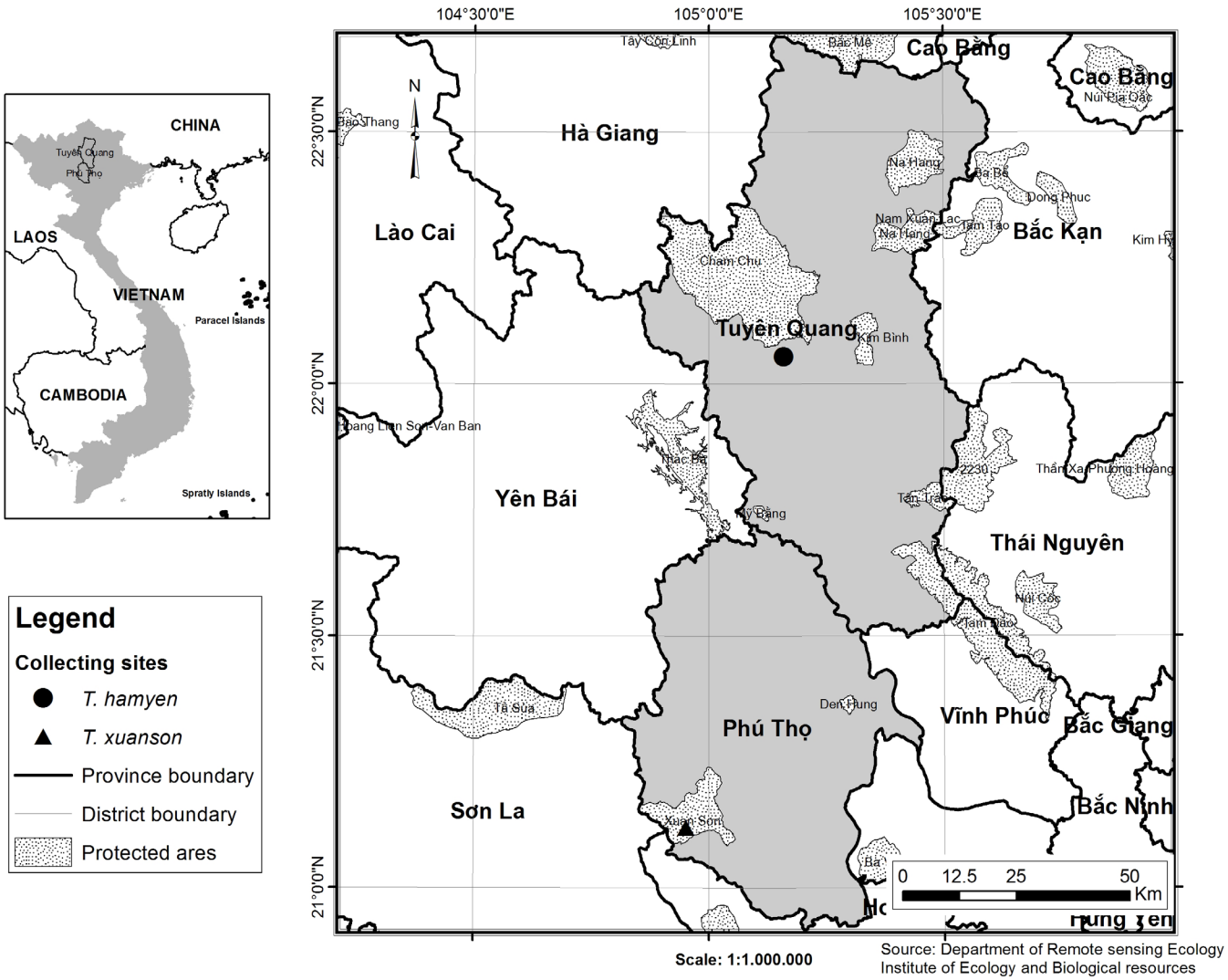

Fig. 1. Collection sites of *Tiwaripotamon xuanson*, new species and *T. hamyen*, new species.

Paratypes: 2 males (31.6 × 23.7, 32.9 × 25.3), 3 females (30.2 × 23.2, 29.1 × 22.4, 32.6 × 24.5) (IEBR-FC TXx02-06), same data as holotype.

Comparative material. *Tiwaripotamon edostilus* Ng & Yeo, 2001: 1 male (26.1 × 21.4), (IEBR-FC TE01), Cat Ba island, Hai Phong city, Vietnam, 15–170 m, coll. V.T. Do, 18–19 March 2013. *Tiwaripotamon vietnamicum* (Dang & Ho, 2002): 2 males (44.5 × 32.8, 41.3 × 31.2), (IEBR-FC TVn01, NCHUZOOL 13612), Cuc Phuong National Park, Ninh Binh province, Vietnam, 500 m, coll. V.T. Do, 14 May 2013. *Tiwaripotamon vixuyenense* Shih & Do, 2014: 1 male (26.4 × 20.5) (IEBR-FC TVx01), Tung Ba commune, Vi Xuyen district, Ha Giang province, Vietnam, 758 m, coll. N.L. Doan & X.N. Nguyen, 2 July 2013. *Tiwaripotamon pluviosum* Do et al, 2016: 1 male (32.2 × 23.2) (IEBR-FC TPx01), 22°43′466″N 106°39′051″E, Coong village, Duc Quang commune, Ha Lang district, Cao Bang province, Vietnam, 572 m, coll. T.C. Pham, 7 June 2014.

Diagnosis. Small-sized (CW: 29–33 mm). Carapace about 1.3 times broader than long, transverse, low, dorsal surface relatively flat, glabrous; regions not well-defined, cervical groves indiscernible; postorbital cristae indistinct, rounded, smooth, not obviously confluent with epibranchial tooth; external orbital angle triangular, with acute tip; epibranchial tooth very small, low; anterolateral margins of carapace very weakly serrate on anterior part. Ambulatory legs long and slender; 4th pair with length of merus about 5.6 times width. Suture between sternites 3 and 4 distinct, demarcated as a deep groove in the middle. Telson broadly triangular with lateral margins gently convex. G1 terminal segment upcurved, subconical, without dorsal flap in posterior part.

Description. Carapace transverse, low, about 1.3 time broader than long (n=6); dorsal surface relatively flat; glabrous; regions not well-defined, cervical grooves undiscernible, H-shaped depression shallow but distinct (Fig. 2A). Epigastric cristae very weak, indistinct, not sharp, smooth to very weakly rugose, separated by short, shallow groove that opens up into inverted V-shape posteriorly, no groove between epigastric cristae and postorbital cristae; postorbital cristae indistinct, rounded, smooth, not obviously confluent with epibranchial tooth, weakens without breaking up into granules and rugae just before epibranchial tooth; regions behind epigastric and postorbital cristae smooth (Fig. 2A, B). Frontal margin broadly emarginate medially; frontal region turned downwards, appearing relatively narrow

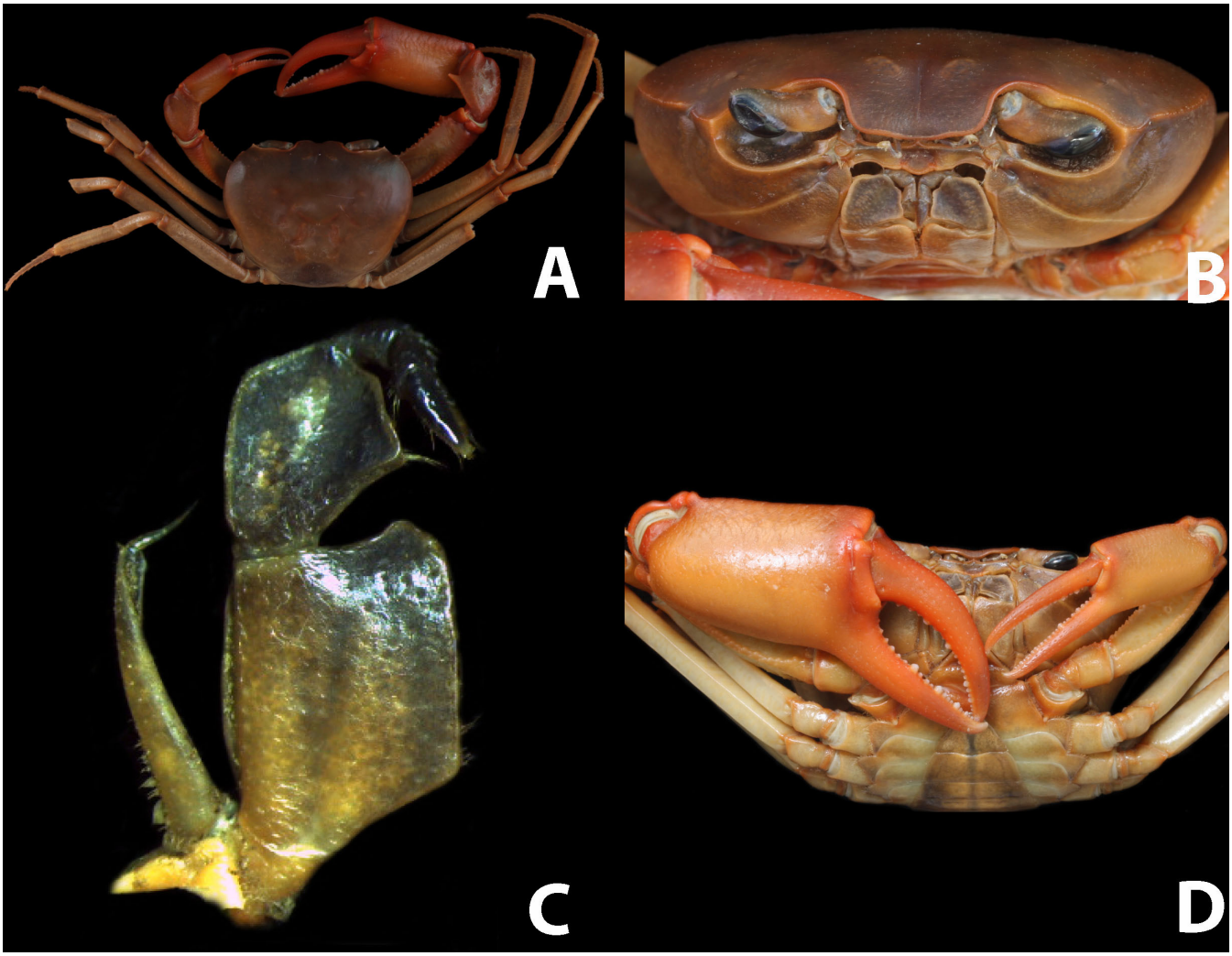

Fig. 2. *Tiwaripotamon xuanson*, new species, holotype, male (CW 33.1 mm), IEBR-FC TXx01. A, carapace, dorsal view; B, frontal view; C, left third maxilliped; D, chela outer view.

from dorsal view, smooth; supra- and infraorbital margins distinctly cristate, supraorbital margin sinuous, infraorbital margin almost straight; orbital region smooth, relatively narrow; eyes normal; subhepatic and subbranchial regions smooth (Fig. 2B). External orbital angle triangular, with acute tip, outer margin convex, weakly cristate to smooth; epibranchial tooth very small and low but distinct, separated from external orbital angle by a narrow and shallow triangular cleft; anterolateral margin slightly convex, very weakly serrate on anterior part; posterolateral margin entire, almost straight, not strongly convergent posteriorly; branchial and metabranchial regions smooth (Fig. 2A). Epistome anterior margin with median triangle; posterior margin with low median triangular tooth, slightly crenulated laterally, with outer part deeply concave (Fig. 2B).

Ischium of third maxilliped subrectangular, about 1.4 times longer than broad, with shallow longitudinal median sulcus; merus squarish, longer than half (0.6 times) of ischium length, with concave outer surface; palp normal; exopod relatively short, slightly exceeding upper edge of ischium, blunt tooth on distal part of inner margin weakly developed, with short but distinct flagellum, shorter than half width (0.4) of merus (Fig. 2B, C).

Chelipeds subequal, with outer surface smooth, subequal in length to palm, tips overlapping. Right chelipeds with length of palm+pollex about 3.0 times palm height, carpus with smooth outer surface, with strong, obliquely directed, subdistal spine on inner margin; merus with serrated edges, without subterminal spine (Fig. 2D).

Ambulatory legs (Fig. 2A) glabrous, conspicuously long and slender; all dactyli and propodi with obvious spines in both upper and bottom margins; second leg with dactylus about 10.1 times longer than proximal width, propodus about 6.2 times longer than broad and about 1.1 times longer than dactylus, carpus about 0.6 times length of dactylus, merus about 1.4 times longer than dactylus (n=6); fourth leg with dactylus about 9.5 times longer than proximal width, propodus about 0.9 times length of dactylus, carpus about 0.6 times length of dactylus (n=6), merus without serrated upper margins, about 5.6 times longer than proximal width (n=6) and about 1.3 times longer than dactylus (n=6).

Suture between anterior thoracic sternites 2 and 3 complete, distinct, convex in the middle; groove between sternites 3 and 4 distinct, demarcated as a deep groove (Fig. 3A); thoracic sternites 5 and 6 medially interrupted; sternites 7

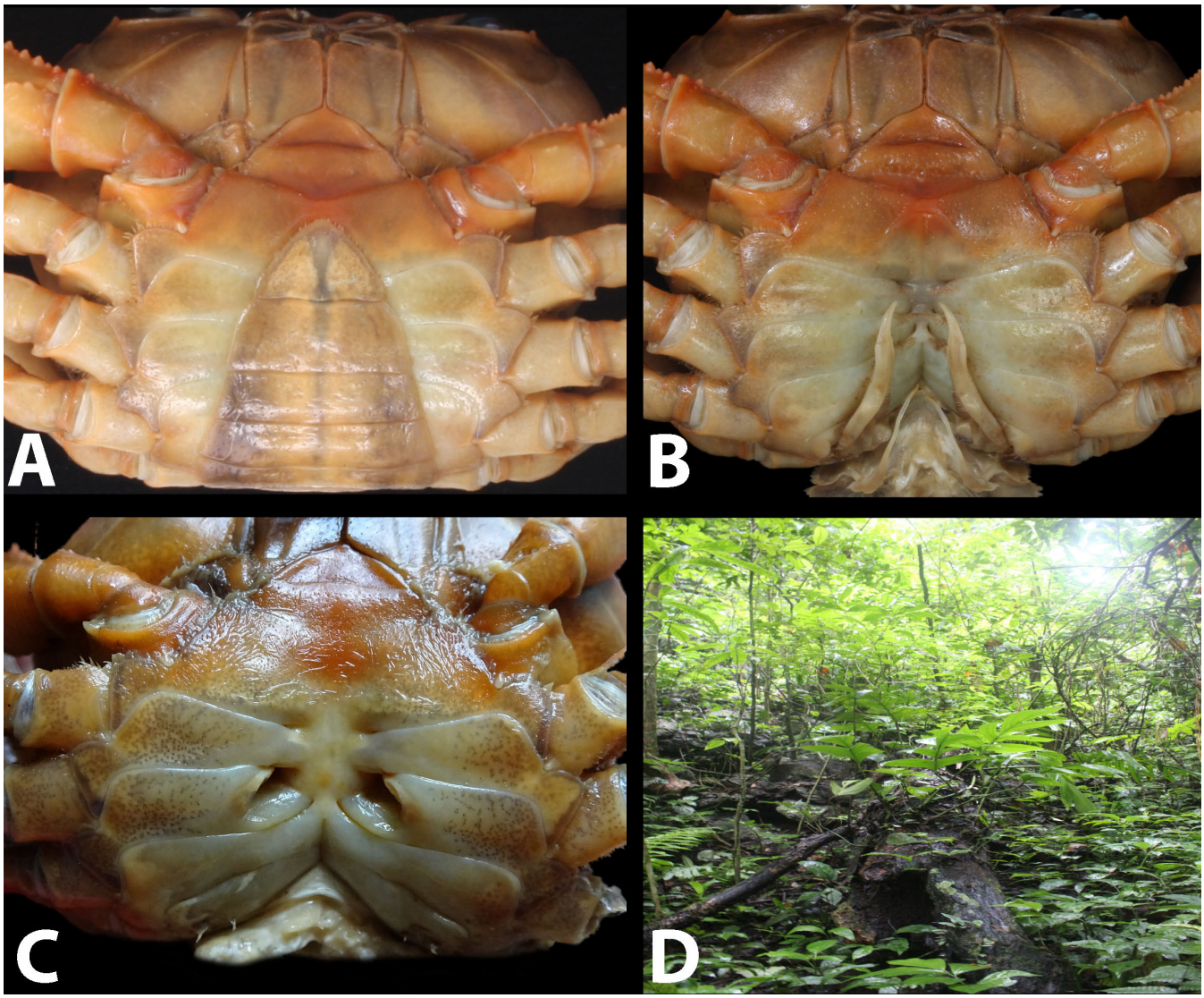

Fig. 3. *Tiwaripotamon xuanson*, new species, holotype, male (CW 33.1 mm), IEBR-FC TXx01. A, ventral view; B, sternoabdominal cavity showing G1s and G2s; C, female gonopore (CW 32.6 mm), IEBR-FC TXx06; D, A habitat in Ten mountain, Xuan Son National Park, Thanh Son District, Phu Tho Province, Vietnam.

and 8 medially separated by distinct longitudinal median suture. Male abdominal cavity reaching imaginary line joining posterior points of cheliped bases (below the suture between thoracic sternites 3 and 4) (Fig. 3B). Tubercles of male abdominal-locking mechanism positioned in thoracic sternite 5 (Fig. 3B).

Male abdomen broadly triangular; telson broadly triangular, broader than long (about 1.6 times), lateral margins gently convex, tip rounded, subequal in length to sixth segment; segment 6 with proximal width about 2.5 times length, lateral margins almost straight; lateral margins of segments 4 to 5 straight; lateral margins of segment 3 gently convex (Fig. 3A).

Gl sinuous, reaching to the tubercle of the fifth sternum; terminal segment upcurved, about 0.3 times length of subterminal segment, about 2.6 times longer than proximal width, without dorsal flap, subconical; subterminal segment relatively slender, sinuous, without neck-like distal part and subdistal cleft or shelf on outer margin (Figs. 3B, 4A–D). G2 slightly shorter or equal with G1, with distal segment about 0.4 times length of basal segment (Fig. 4E, F). Female gonopore in thoracic sternite 6, subovate, without operculum, opened posterio-mesially; anterio-external margin partially covered by raised rim; posterio-mesial margin surrounded by a low raised rim (Fig. 3C).

Etymology. The new species is named after the type locality, Xuan Son National Park. The name is used as a noun in apposition.

Live colouration. Carapace reddish, chela and ambulatory legs red.

Ecological notes. This species inhabits limestone mountains far from water bodies, on the forest floor. One specimen was found in a fallen dead tree (Fig. 5). The other specimens were found in rock cavities and under leaf litter.

Remarks. The carapace shape of the new species is relatively similar with *T. pluviosum*. However, the G1 of these two species obviously different (G1 terminal segment is upcurved

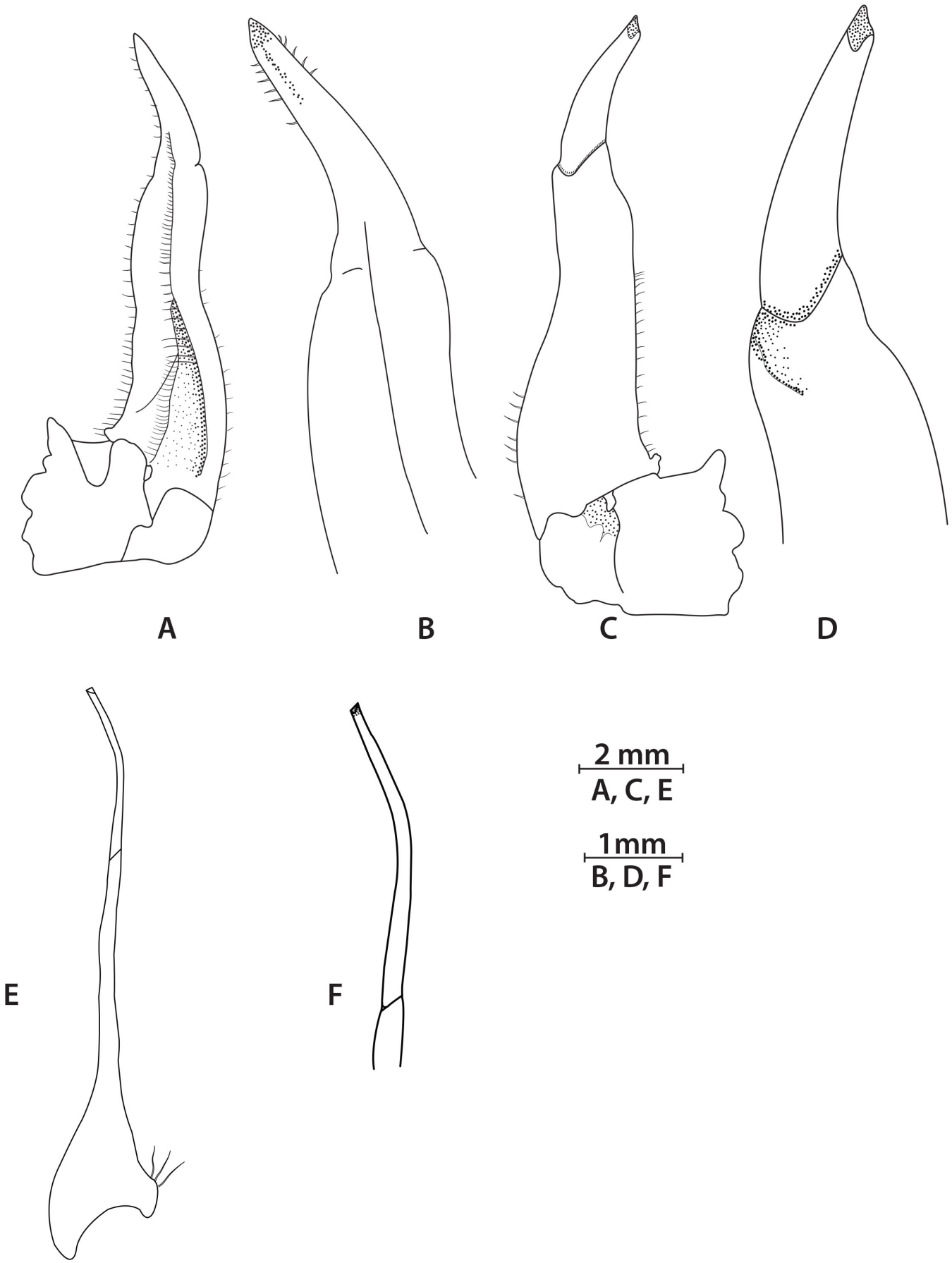

Fig. 4. *Tiwaripotamon xuanson*, new species, holotype, male (CW 33.1 mm), IEBR-FC TXx01. A–F, right G1: A, ventral view; B, ventral view of terminal segment; C, dorsal view; D, dorsal view of terminal segment; E, right G2; F, right G2 of terminal segment.

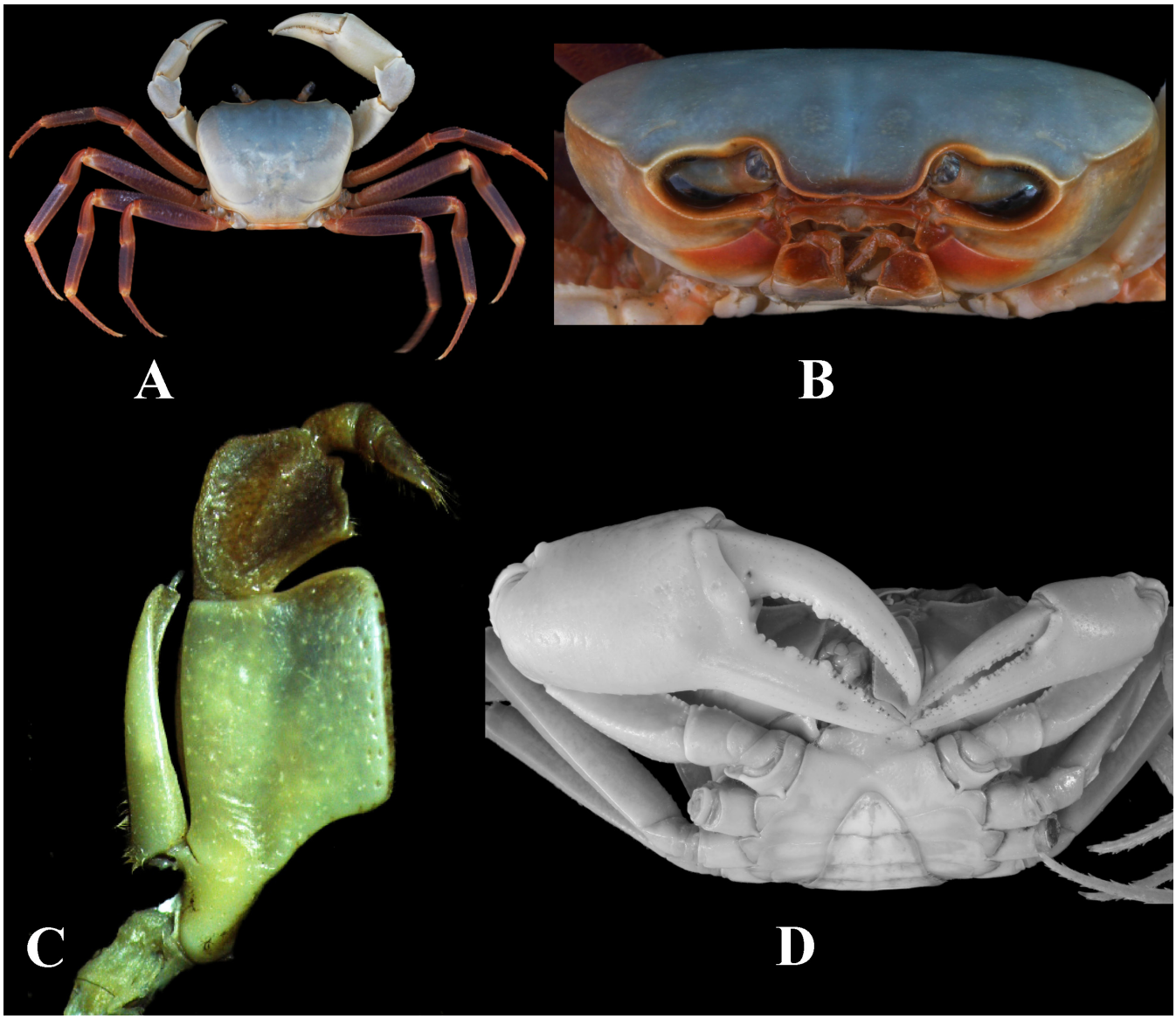

Fig. 5. *Tiwaripotamon hamyen*, new species, holotype, male (CW 41.7 mm), IEBR-FC THx01. A, carapace, dorsal view; B, frontal view; C, left third maxilliped; D, chela outer view.

or upturned, about 0.30 times length of subterminal segment and 2.6 times longer than proximal width vs. strongly upcurved, about 0.34 times length of subterminal segment and 3.0 times longer than proximal width in *T. pluviosum*) (Fig. 4A–D; cf. Do et al., 2016: Figs. 2–3).

Compared to *T. araneum*, this new species can be distinguished by a suite of characteristics: carapace more transverse, about 1.4 times broader than long; anterolateral margins of carapace very weakly serrate; branchial and metabranchial regions smooth; epistome posterior margin outer part deeply concave; ischium of third maxilliped subrectangular, about 1.4 times longer than broad (vs. carapace slightly transverse, about 1.24 times broader than long; anterolateral margins of carapace distinctly serrated in upper part; branchial and metabranchial regions weakly rugose; epistome posterior margin outer part gently concave; ischium of third maxilliped squarish, about 1.2 times longer than broad) (Fig. 2A–C; cf. Ng & Yeo, 2001: Figs. 2C, 3).

Compared to *T. annamense*, the new species showed differences in the following characteristics: anterolateral margins of carapace very weakly serrate; ischium of third maxilliped subrectangular, about 1.4 times longer than broad; suture between sternites 3 and 4 distinct, demarcated as a deep groove; lateral margins of telson gently convex; terminal segment upcurved, stouter, about 0.3 times length of subterminal segment, about 2 times longer than proximal width (vs. anterolateral margins of carapace distinctly serrated; ischium of third maxilliped squarish, about 1.2 times longer than broad; suture between sternites 3 and 4 absent; lateral margins of telson are gently concave; terminal segment more upcurved, more slender, about 0.4 times length of subterminal segment, about 2.3 times longer than proximal width) (Figs. 2A–C; 4A–D; cf. Ng & Yeo, 2001: Figs. 1, 2).

Compared to *T. vietnamicum*, the new species can be distinguished by the following characteristics: anterolateral margins of carapace very weakly serrate; epibranchial tooth very small and low but distinct; ambulatory legs slender,

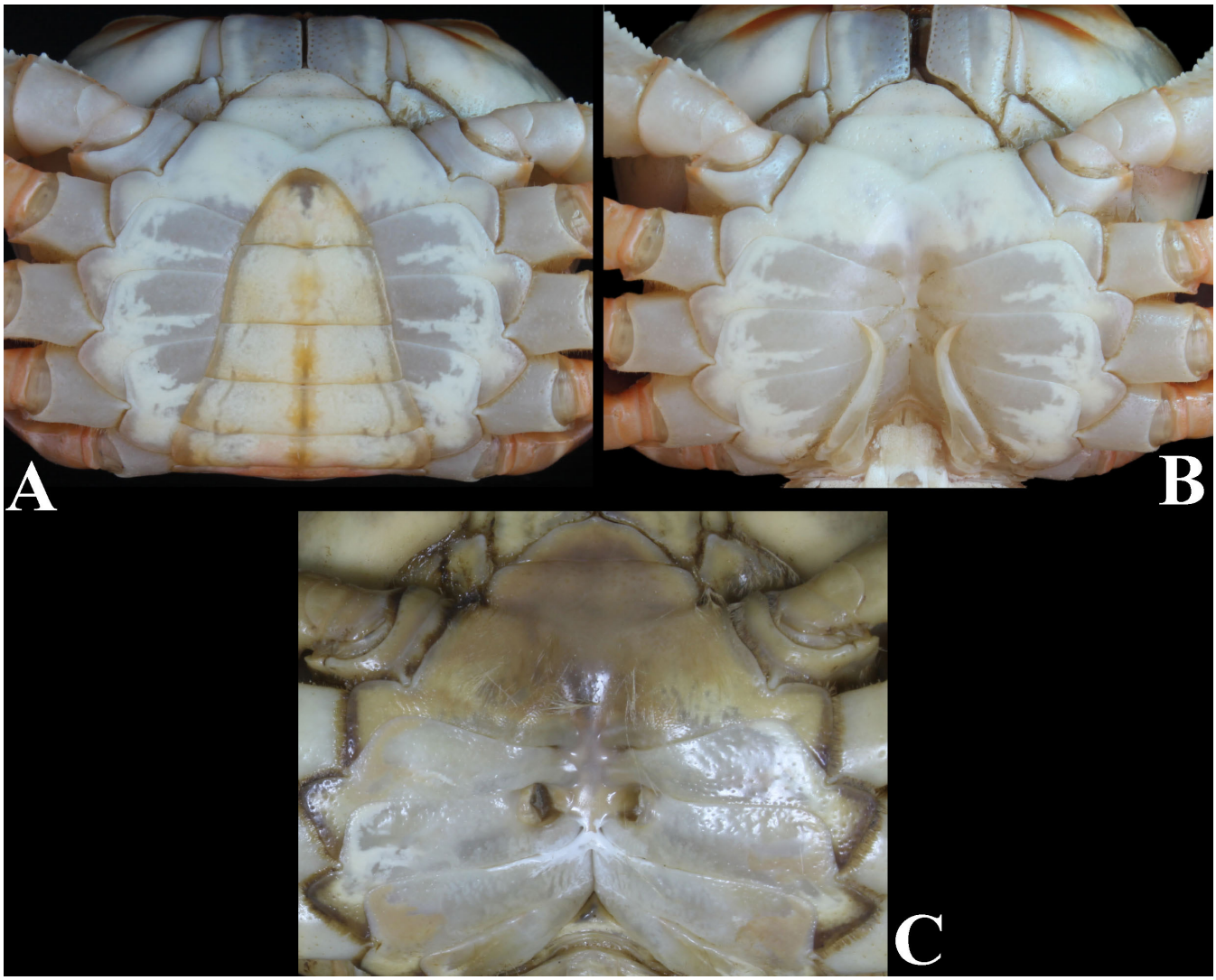

Fig. 6. *Tiwaripotamon hamyen*, new species, holotype, male (CW 41.7 mm), IEBR-FC THx01. A, ventral view; B, sternoabdominal cavity showing G1s and G2s; C, female gonopore (CW 43.8 mm), IEBR-FC THx07.

merus of fourth pair leg about 5.6 times longer than broad; terminal segment of G1 curves inward (vs. anterolateral margins of carapace very weakly smooth; epibranchial tooth relatively much weaker and sometimes even absent; ambulatory legs stouter, merus of fourth pair leg about 5.1; terminal segment of G1 curves outward) (Figs. 2A–D, 4A–D; cf. Shih & Do, 2014: Fig. 6; Dang & Ho, 2012: Fig. 78).

This species can be distinguished from *T. hamyen*, new species, by some characteristics including ambulatory legs stouter, merus of fourth pair leg about 5.6 times longer than broad; terminal segment of G1 curves inward (vs. ambulatory legs slender, merus of fourth pair leg about 4.1 times longer than broad; terminal segment of G1 curves outward). (Figs. 2A, 3B, 4A–D, 5A, 6B, 7A–D).

This new species can be distinguished from *T. vixuyenense* by characteristics such as ambulatory legs stouter; G1 slender, sinuous (vs. ambulatory legs more slender; G1 conspicuously short, stout, straight). (Figs. 2A, 4A–D; cf. Shih & Do, 2014: Figs. 3, 4).

Tiwaripotamon xuanson can be easily separated from other *Tiwaripotamon* species by the absent of dorsal flap in the terminal segment of the G1 (vs. dorsal flap present in *T. edostilus* (cf. Ng & Yeo, 2001: Fig. 5), *T. pingguoense* (cf. Dai & Naiyanetr, 1994: Fig. 1), *T. pluviosum* (cf. Do et al., 2016: Fig. 2), and *T. xiurenense* (cf. cf. Dai & Naiyanetr, 1994: Fig. 2).

***Tiwaripotamon hamyen*, new species**
(Figs. 6–8)

Material examined. Holotype: male (41.7 × 32.3) (IEBR-FC THx01), 22°03.341′N 105°09.638′E, Binh Xa commune, Ham Yen district, Tuyen Quang province, Vietnam, 232 m, coll. Chu H. Q., 27 August 2015.

Paratypes. 5 males (37.2 × 28.4, 36.4 × 28.3, 35.7 × 27.8, 35.0 × 27.3, 29.4 × 23.2) (IEBR-FC THx02–06), 3 females (43.8 × 33.0, 40.6 × 29.8, 40.0 × 30.8) (IEBR-FC THx07–09), same data as holotype.

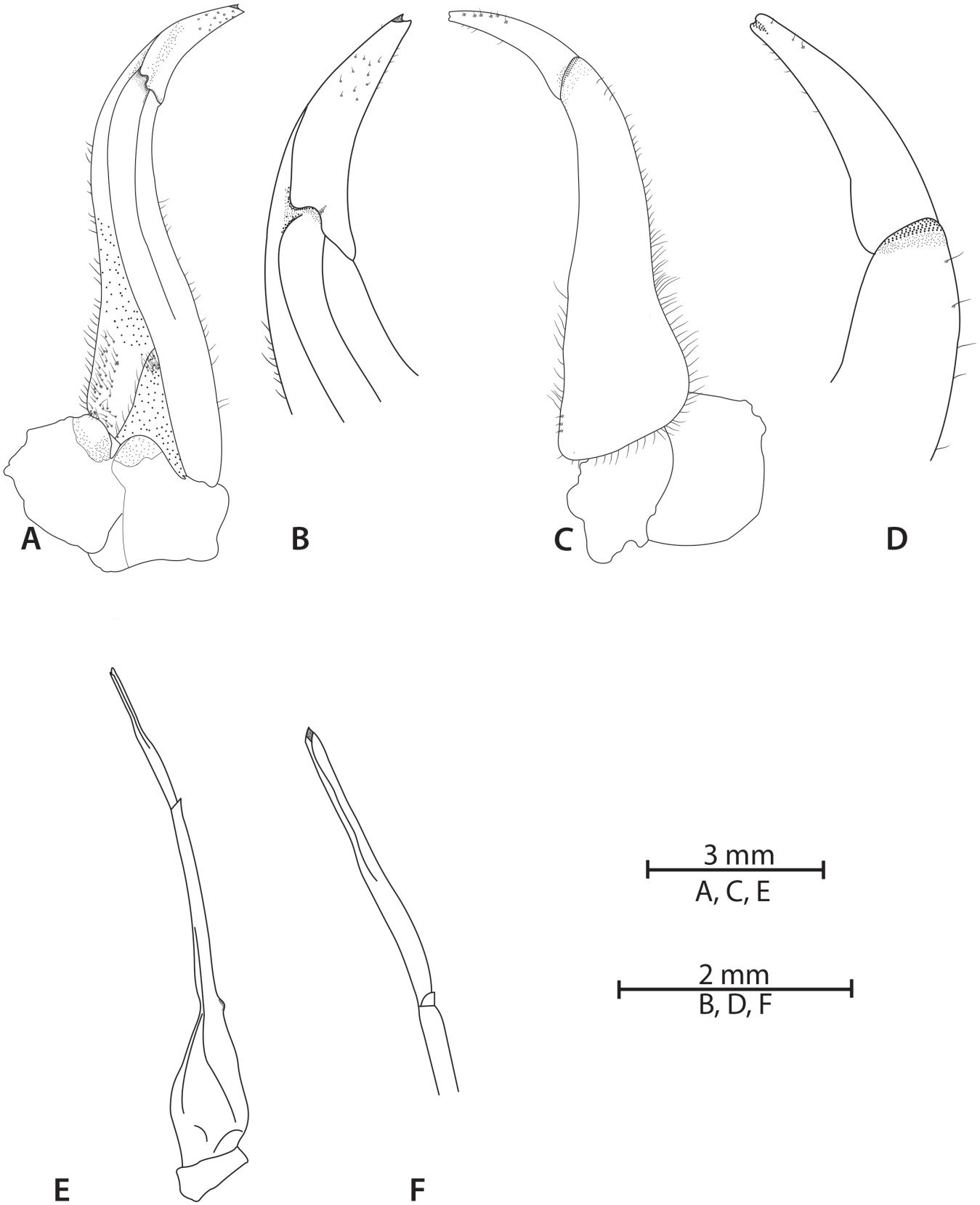

Fig. 7. *Tiwaripotamon hamyen*, new species, holotype, male (CW 41.7 mm), IEBR-FC THx01. A–F, right G1: A, ventral view; B, ventral view of terminal segment; C, dorsal view; D, dorsal view of terminal segment; E, right G2; F, right G2 of terminal segment.

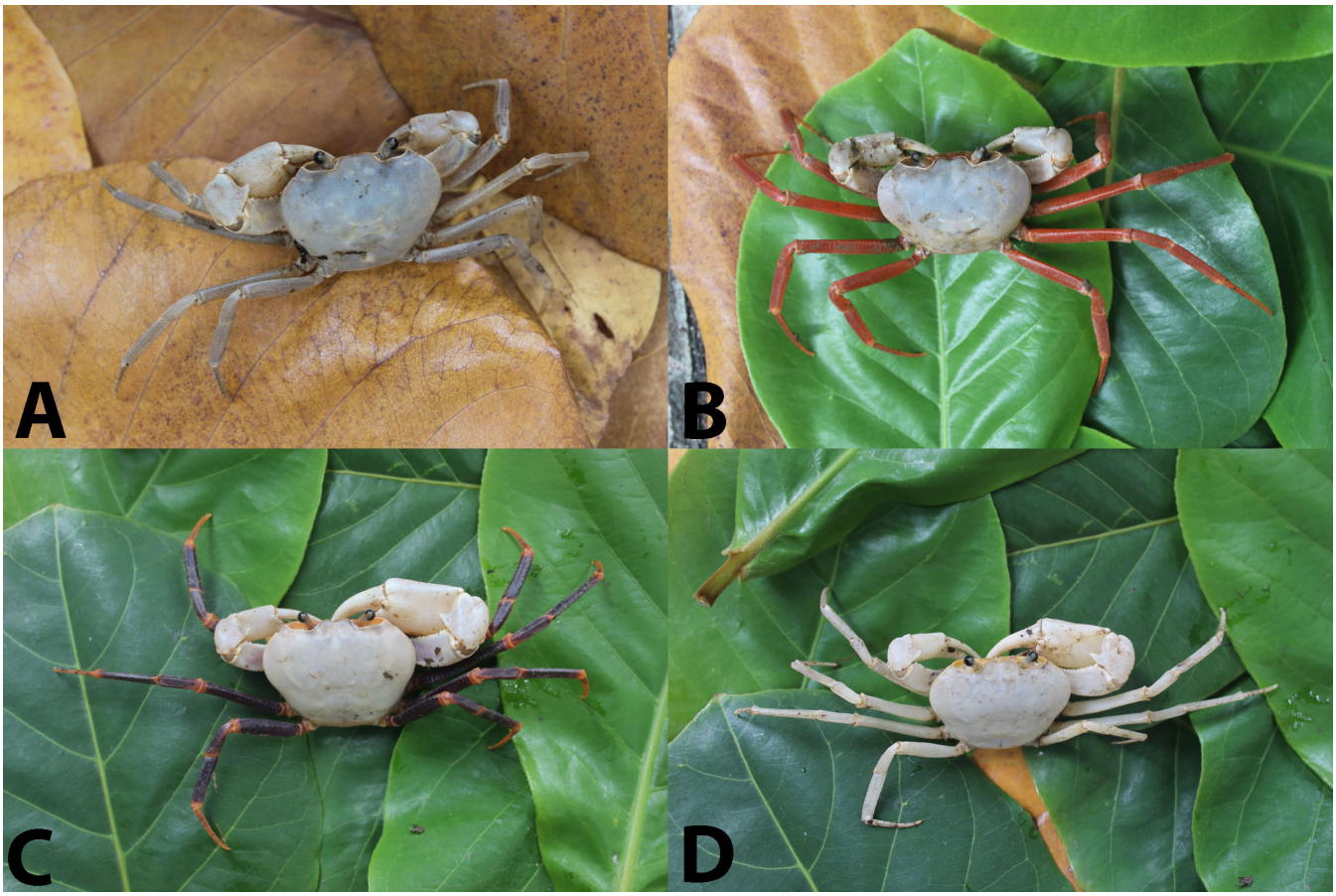

Fig. 8. A–D, *Tiwaripotamon hamyen*, new species, with differences living colour in carapace and ambulatory legs.

Comparative material. *Tiwaripotamon edostilus* Ng & Yeo, 2001: 1 male (26.1 × 21.4), (IEBR-FC TE01), Cat Ba island, Hai Phong city, Vietnam, 15–170 m, coll. V.T. Do, 18–19 March 2013. *Tiwaripotamon vietnamicum* (Dang & Ho, 2002): 2 males (44.5 × 32.8, 41.3 × 31.2), (IEBR-FC TVn01, NCHUZOOL 13612), Cuc Phuong National Park, Ninh Binh province, Vietnam, 500 m, coll. V.T. Do, 14 May 2013. *Tiwaripotamon vixuyenense* Shih & Do, 2014: 1 male (26.4 × 20.5) (IEBR-FC TVx01), Tung Ba commune, Vi Xuyen district, Ha Giang province, Vietnam, 758 m, coll. N.L. Doan & X.N. Nguyen, 2 July 2013. *Tiwaripotamon pluviosum*: 1 male (32.2 × 23.2) (IEBR-FC TPx01), 22°43′466″N 106°39′051″E, Coong village, Duc Quang commune, Ha Lang district, Cao Bang province, Vietnam, 572 m, coll. T.C. Pham, 7 June 2014.

Diagnosis. Medium-sized (CW: 28–44 mm). Carapace about 1.3 times broader than long, transverse, low; dorsal surface flat, glabrous; regions poorly defined, cervical groves indiscernible, H-shaped depression very shallow. Anterolateral margins of carapace very weakly serrated (in males) and nearly smooth (in females); postorbital cristae indistinct, smooth, not obviously confluent with epibranchial tooth. Epibranchial tooth very small, low, not prominent. Posterior margin of epistome with low median blunt tooth. Exopod of third maxilliped with very short flagellum, about 0.1 times width of merus. Ambulatory legs long and slender; 4th pair with length of merus about 4.1 times width. G1 terminal segment curved outwards, hook-shaped, without dorsal flap in posterior part. Telson triangular with lateral margins gently convex.

Description. Carapace transverse, low, about 1.3 time broader than long (n=9); dorsal surface flat, glabrous; regions poorly defined, cervical grooves indiscernible, H-shaped depression very shallow, indiscernible (Fig. 5A). Epigastric cristae very low, weak and smooth, separated by very short, shallow groove that opens up into inverted V-shape posteriorly, no groove between epigastric cristae and postorbital cristae; postorbital cristae weakens, indistinct, smooth, not obviously confluent with epibranchial tooth; regions behind epigastric and postorbital cristae smooth (Fig. 5A). Frontal margin slightly emarginate medially; frontal region turned downwards, smooth; supra- and infraorbital margins cristate, supraorbital margin sinuous, infraorbital margin almost straight; orbital region smooth, relatively narrow; subhepatic and subbranchial regions smooth (Figs. 5A, 6B). External orbital angle triangular, outer margin convex, weakly cristate to smooth; epibranchial tooth very small and low, separated from external orbital angle by narrow and shallow triangular cleft; anterolateral margin slightly convex, very weakly serrated (in males) and nearly smooth (in females); posterolateral margin entire, almost straight, not strongly convergent posteriorly; branchial and metabranchial regions smooth (Figs. 5A, 6B). Epistome anterior margin with median triangle; posterior margin with low median blunt tooth, slightly crenulated laterally, with outer part deeply concave (Fig. 5B).

Ischium of third maxilliped subrectangular, about 1.4 times longer than broad, with shallow longitudinal median sulcus; merus squarish, longer than half (0.6 times) of ischium length; exopod relatively short, equal or slightly exceeding upper edge of ischium, with very short flagellum, about 0.1 times width of merus (n=9) (Fig. 5C).

Chelipeds (Fig. 5D) subequal; outer surface smooth to slightly rugose, subequal in length to palm, tips overlapping. Right chelipeds with length of palm+pollex about 3.1 times palm height, carpus with smooth outer surface, with strong, obliquely directed, subdistal spine on inner margin; merus with serrated edges, without subterminal spine.

Ambulatory legs (Fig. 5A) glabrous, long and slender; second leg with dactylus about 8.4 times longer than proximal width, propodus about 4.7 times longer than broad and equal or slightly longer than dactylus, carpus about 0.6 times length of dactylus, merus about 1.4 times longer than dactylus (n=9); fourth leg with dactylus about 8.3 times longer than proximal width, propodus slightly longer than dactylus, carpus about 0.7 times length of dactylus (n=8), merus without serrated upper margins, about 4.1 times longer than proximal width (n=8) and about 1.4 times longer than dactylus (n=8).

Suture between anterior thoracic sternites 2 and 3 complete, distinct, slightly convex in the middle; groove between sternites 3 and 4 complete, distinct (Fig. 7A). Male abdominal cavity reaching imaginary line joining posterior points of cheliped bases (below the suture between thoracic sternites 3 and 4) (Fig. 7B).

Male abdomen broadly triangular; telson triangular, broader than long (about 1.4 times), lateral margins gently convex, tip rounded, subequal in length to sixth segment; segment 6 with proximal width about 2.2 times length, lateral margins almost straight; lateral margins of segments 4 to 5 straight; lateral margins of segment 3 gently convex (Fig. 6A).

Gl gently sinuous, reaching just to over half of the fourth sternum; terminal segment slender, about 0.4 times length of subterminal segment, about 2.9 times longer than proximal width, without dorsal flap, curved outwards, hook-shaped, opening on tip visible from dorsal and ventral views, distal part of groove for G2 visible on ventral side, tip truncated; subterminal segment relatively slender, sinuous, without neck-like distal part (Figs. 6B, 7A–D). G2 shorter than G1 (0.9 times length of G1) with distal segment about 0.3 times length of basal segment (Fig. 7E, F). Female gonopore in thoracic sternite 6, round, without operculum, opened posterio-mesially (Fig. 6C).

Etymology. The new species is named after the type locality, Ham Yen. The name is used as a noun in apposition.

Live colouration. Carapace and chela milky to light gray, ambulatory legs vary from milky to light gray or purple mixed light orange (Fig. 8A–D).

Ecological notes. This species inhabits limestone mountains. Our observation of this species and other *Tiwaripotamon* species from Vietnam confirm that they have terrestrial habits. They were often found far from water sources like streams and ponds. We observed a female *T. edostilus* carrying juveniles walking on the forest floor not close to any water body. It means these juveniles did not develop in streams or ponds.

Remarks. *Tiwaripotamon hamyen* is easily separated from all other *Tiwaripotamon* species by: (1) median tooth of epistome posterior margin is low and blunt (vs. median tooth of epistome posterior margin is triangular); (2) ambulatory legs are relatively less longer and slender compared to the congeners (the merus of 4th pair leg of this species is about 4.1 longer than broad compared to 4.3 for *T. pingguoense*, 4.5 for *T. annamense* (see Do et al., 2016), 4.8 for *T. pluviosum*, 5.1 times for *T. vietnamicum*, 5.3 times for *T. xiurenense* (unpublished data), 5.6 times for large *T. edostilus* specimens, and 6.5 for *T. vixuyenense* (Shih & Do, 2014); (3) G1 terminal segment is curved outwards, hook shape (vs. curved upwards, not hook shape) (Dai & Naiyanetr, 1994: Figs. 1–2; Ng & Yeo, 2001: Figs. 1–5; Shih & Do, 2014: Figs: 2–7; Dang & Ho, 2012: Fig. 78; Do et al., 2016: Figs: 1–5).

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