

***Sudanonautes kagoroensis*, a new species of freshwater crab
(Decapoda: Potamoidea: Potamonautidae) from Nigeria**

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A freshwater crab, *Sudanonautes kagoroensis* n.sp., is described and illustrated on the basis of 57 specimens from seven localities in the guinea savanna zone of central Nigeria. The taxonomic relationship of *S. kagoroensis* to other freshwater crabs from Nigeria belonging to this genus is discussed and its ecology and distribution are described. Seven species of *Sudanonautes* Bott, 1955 are now known from Nigeria.

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On trouvera ici la description illustrée d'un nouveau crabe d'eau douce, *Sudanonautes kagoroensis* n.sp., description élaborée à la suite de l'examen de 57 spécimens provenant de sept localités de la zone savane Guinée dans le centre du Nigéria. Les relations taxonomiques entre la nouvelle espèce et les autres crabes d'eau douce du Nigéria appartenant à ce genre sont examinées et l'écologie et la répartition de l'espèce sont commentées. Cela porte à sept le nombre d'espèces connues de *Sudanonautes* Bott, 1955 au Nigéria.

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Introduction

Freshwater crabs found in the inland waters of Nigeria belong either to the genus *Sudanonautes* (Bott, 1955) or to the genus *Potamonautes* (Macleay, 1838). The former group inhabits streams or land close to water whereas the latter lives in major rivers (Cumberlidge 1985a). A survey of the freshwater crab fauna of the streams and small rivers of the guinea savanna zone of central Nigeria carried out between 1980 and 1984 revealed the existence of a new species of *Sudanonautes* which is described here.

Until now six species of Nigerian freshwater crabs were assigned to the genus *Sudanonautes* (see Bott 1955, 1964; Cumberlidge 1989, 1991). The original description of this genus recognized only three species, *S. africanus* (A. Milne-Edwards, 1869), *S. aubryi* (H. Milne-Edwards, 1853), and *S. decazei* (A. Milne-Edwards, 1886), and listed five taxa, *chavanesii* (A. Milne-Edwards, 1886), *chaperi* (A. Milne-Edwards, 1887), *orthostylis* (Bott, 1955), *monodi* (Balss, 1929), and *floweri* (DeMan, 1901), as subspecies (Bott 1955). A later revision (Bott 1964) removed *S. decazei* and added *S. pelii* (Herklots, 1861), but still recognized only three species. This latter classification was followed in some of the subsequent taxonomic accounts of the group from West Africa (cf. Monod 1977, 1980).

More recent changes to Bott's (1955, 1964) classifications of *Sudanonautes* have included the reassignment of *chaperi* to the genus *Liberonautes* Bott, 1955 (Cumberlidge 1985b), and the recognition of *orthostylis* (see Cumberlidge 1989), *monodi*, and *floweri* as full species of *Sudanonautes* (Cumberlidge 1991). The description of *S. kagoroensis* n.sp. brings to seven the total of species of *Sudanonautes* known from Nigeria.

Sudanonautes kagoroensis is described from adult male and female and juvenile specimens. The new species is compared with and distinguished from other species belonging to this genus, and distributional and ecological notes for *S. kagoroensis* are provided.

Materials and methods

The first indication of the existence of a new species of freshwater crab in central Nigeria was the discovery of the carapace of an adult

specimen, collected at Abuja, Nigeria, in 1982 by Mallam U. Mumuni. The first live specimen, a juvenile, was caught later that year by Dr. A. Brown at Kagoro, Kaduna State, in central Nigeria. Collections by the author in 1983 at the same locality and at a second site in the vicinity revealed 12 more specimens, but did not include an adult male. A more detailed survey of the crab fauna of the region in 1984 resulted in the capture of 42 more specimens, including juveniles and several adults of both sexes.

Specimens of *S. kagoroensis* were collected from streams flowing through the Kagoro forest, a region of riparian high forest in Kaduna State, central Nigeria. Crabs were either taken by hand from under large stones on the stream bed, or dug from burrows they made in muddy banks of the streams. Four specimens were taken at the Nigerian Electric Supply Company (NESCO) Hydroelectric Power Station near Jos, from an exposed stream bed created by temporarily arresting the flow of water upstream. Many more crabs of the same species were seen fleeing under rocks and in deeper water nearby, but they escaped collection. This species ventures onto land at night according to reports of local people, who regularly catch *S. kagoroensis* for food and medicinal use. At one locality (Pasakwauri, Nigeria) *S. kagoroensis* was collected together with *S. floweri*. Maturity in females was judged by the width of the abdomen: adult females have a greatly widened abdomen covering the sternum and overlapping the coxae of the walking legs. This creates an abdominal brood pouch that enables females to carry their brood of eggs and hatchlings. The abdomens of perpubertal females are slimmer and do not completely cover the sternum. The lower limit of the range for the pubertal moult was taken as the carapace width of the largest immature specimen, and the upper limit as the carapace width of the smallest mature specimen.

The type material of *S. floweri* and specimens of *S. monodi* and *S. aubryi* were examined in the British Museum (Natural History), London (BMNH); the types of *S. aubryi* and *S. monodi* were examined in the Muséum National d'Histoire Naturelle, Paris (MNHN). Specimens of *S. africanus*, *S. pelii*, *S. aubryi*, *S. monodi*, *S. floweri*, and *S. orthostylis* from Nigeria held in the author's collection were also examined. Male and female specimens of *S. kagoroensis*, designated the holotype and paratype, have been placed in the BMNH, and a paratype has been placed in the MNHN. The following abbreviations are used: juv., juvenile; m., male; f., female; spec., specimen; prev. undet., previously undetermined; CW, carapace width at widest point; CL, carapace length, measured along median line; CT, cephalothorax thickness, maximum depth of cephalothorax; FW, front width, width of front measured along anterior margin.

MATERIAL EXAMINED: NIGERIA: Agban River, tributary of the Mada River, Kagoro, Kaduna State, 9°32'N, 8°9'E, (19 m., 10 f., 5 juv.; largest male, CW 63.0 mm, is holotype BMNH No. 1984.6.12.1), 11.IV.1984 (leg. N. Cumberlidge); Abuja, Federal Capital territory, central Nigeria, 9°5'N, 7°30'E, carapace only (1 m.), 1982 (leg. U. Mumuni); scouting camp, Kagoro, near Kafanchan, Kaduna State, from medium-fast stream, tributary of the Mada River, gravel bed, under boulders, 9°35'N, 8°9'E (1 juv.), 15.XI.1982 (leg. A. Brown); (9 m., 3 f.,) 24.IV.1983 (leg. N. Cumberlidge and L. M. Bourgault); on escarpment 60 km south of Jos, white-water stream with big boulders, crabs taken by hand from crevices and from mud borrows at the side of stream, above water level, tributary of the Mada River, 9°35'N, 8°41'E (1 m., 3 f.), 25.IV.1983 (leg. N. Cumberlidge and L. M. Bourgault); Pasakwauri, Kaduna State, River Samu, tributary of the Mada River, 9°28'N, 8°6'E (1 juv.), 12.IV.1984 (leg. N. Cumberlidge); bottom of Kurra Falls, Kurra, Plateau State, tributary of Mada River, in shallow water on weir and in deep pool at outlet of the NESCO Hydroelectric Power Station, 9°37'N, 8°50'E (1 m., 3 f.), 3.VI.1984 (leg. N. Cumberlidge and L. M. Bourgault); United Africa Company Guest House, Jos, Plateau State, 9°55'N, 8°52'E (1 f.), BMNH (prev. undet., date and collector unrecorded).

Systematics

SUPERFAMILY Potamoidea Bott, 1970

FAMILY Potamonautidae Bott, 1970

GENUS *Sudanonautes* Bott, 1955

Sudanonautes kagoroensis n.sp.

Figs 1a–1f, 2a–2e, 3a, 3b

Description

Based mainly on the holotype from the Agban River (Figs. 1c–1e, 2a–2d). *Carapace*: Texture smooth, no granules visible even under magnification; cervical groove faint, cardiac, semi-circular grooves deep. Cephalothorax ovoid, rounded, widest at anterior third, lacking large pointed teeth, somewhat flattened (CT/CW = 0.31), maximum depth in anterior region. Carapace length more than two-thirds carapace width (CL/CW = 0.67). Anterior margin of front indented in middle, curving sharply under; front wide, less than one-third carapace width (FW/CW = 0.27). Postfrontal crest wavy, unbroken, curving downward at each end, meeting epibranchial tooth, midgroove short, forked, deep. Exorbital tooth blunt, low; intermediate tooth reduced to tiny notch; epibranchial tooth almost undetectable. Anterolateral margin of carapace smooth, with faint low teeth visible only under magnification. Posterior margin of carapace curving inward, forming continuous unbroken curve with anterolateral margin. Posterior margin about two-thirds as wide as widest point of carapace.

Distal segment of mandibular palp in one piece, not bifurcated, of potamonautid type; tuft of hairs at junction between distal segment and penultimate segment. Third maxillipeds with inner margins touching, merus broad, filling entire oral field except for oval efferent respiratory openings, distinct vertical groove on ishium, long flagellum on epipodite (Fig. 1c). Lateral and longitudinal flank grooves deep, distinct, dividing flanks into three parts; longitudinal flank groove beginning beneath orbit, curving posteriorly across flanks; lateral flank groove beginning at epibranchial corner, curving forward beneath intermediate tooth, joining longitudinal flank groove. Abdomen relatively broad, widest at third segment. First sternal groove deep, distinct,

second sternal groove marked only by two deep notches at outer ends. *Gonopods* (Figs. 2a–2d): Gonopod 1 end segment beginning as straight continuation of penultimate segment, then curving outward at halfway point, relatively long, almost half length of penultimate segment (ratio end to penultimate segment 1:2.2), terminating in upcurving pointed tip. Viewed from lateral aspect, middle section of end segment distinctly widened at inner margin. Longitudinal groove beginning at junction between two segments, ending at about two-thirds length of end segment; penultimate segment slim, not greatly widened; deep longitudinal groove on inner surface for reception of gonopod 2 meeting longitudinal groove of end segment at junction between segments. Gonopod 2 shorter than gonopod 1 (reaching only junction between segments of gonopod 1); end segment of *Sudanonautes* type; extremely short, about one-thirteenth as long as penultimate segment (1:13.4); not solid, sides thin, folded inward, inclosing inward-facing hollow; tip rounded; penultimate segment widest at base, tapering sharply inward about one-third along length, last two-thirds forming long, thin, upright process supporting end segment. *Chelae* (Figs. 1d, 1e): Right chela of adult male slightly longer (50.0 mm) than left (44.5 mm), two moderate teeth on prehensile edge of dactylus bracketing similar teeth on index. Left chela more slender, smaller than right, showing no large teeth, closed fingers almost touching, not enclosing space; tip of dactylus overlapping tip of immovable finger when chela closed; small longitudinal gap between closed fingers; cutting edges of fingers with small but distinct teeth over entire length; first tooth on carpus of both chela large, tapering, pointed; second carpal tooth small, low, blunt, almost absent, another low tooth visible behind; inner and outer margins of merus of right chela distinctly serrate. *Walking legs* (Fig. 1f): Slender, proportions of various segments of different walking legs similar.

Female and juvenile

Dimensions of carapace (CL, CT, and FW) of *S. kagoroensis* increasing with body size (CW) (Fig. 3a). Same dimensions expressed as ratio of CW reveal different relationships (Fig. 3b). Carapace of juveniles proportionally shorter than that of adults; highly significant negative correlation ($r = 0.766$, $P < 0.01$, $df = 43$) between CL/CW values (Fig. 3b). FW of juveniles proportionally less than that of adults; highly significant negative correlation ($r = 0.653$, $P < 0.01$, $df = 43$) between FW/CW values (Fig. 3b). No significant correlation ($r = 0.118$, $P > 0.05$, $df = 43$) between carapace thickness and body size, indicating that carapaces of larger crabs are not necessarily more arched than those of smaller specimens (Fig. 3b).

Right chela of adult females slightly longer than left; little difference in relative sizes of right and left chelae of prepubertal specimens (CD < 50.0 mm). Anterolateral margin of carapace of juveniles of both sexes (CW = 31.5, 32.0, 32.0, 34.5 mm) bearing row of small rounded teeth (this margin smooth in adults). Palms of right and left chelipeds of juveniles (CW = 28.0, 30.0, 31.5 mm) not inflated; cutting edges of fingers meeting, not enclosing a space. Inner edge of end segment of gonopod 1 of juvenile male (CW = 31.0 mm) lacking widened midsection but showing faint longitudinal groove; tip lacking upward curve seen in adults.

Size

Largest known specimen of *S. kagoroensis*, female from Kagoro, Nigeria, with CW of 63.5 mm (Figs. 1a, 1b). Pubertal moult between CW 40 and 50 mm. CW of smallest specimen collected is 16.0 mm.

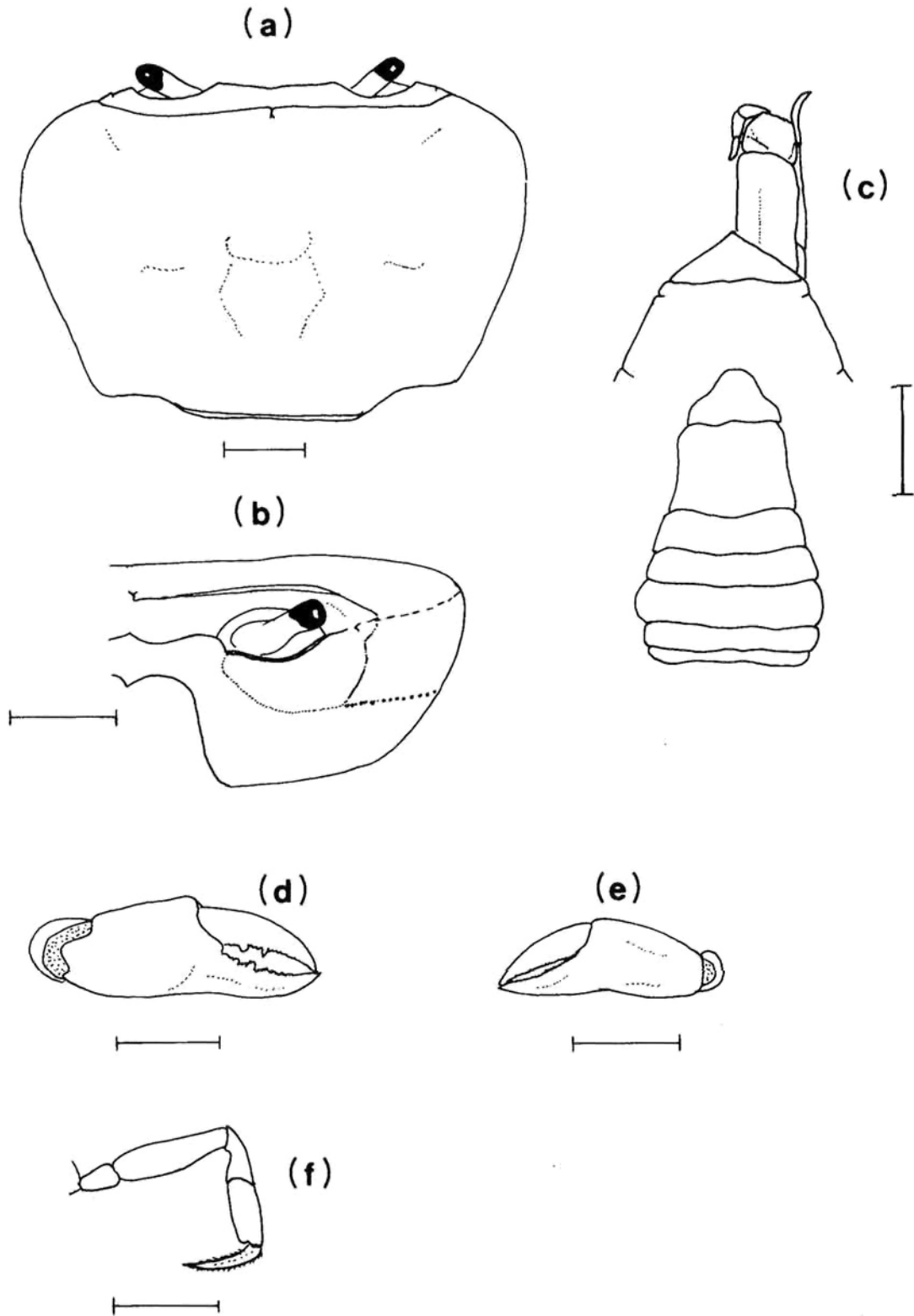


FIG. 1. *Sudanonautes kagoroensis* n.sp. from Agban River, Kagoro, Nigeria (*a* and *b*, female, carapace width 63.5 mm; *c-e*, male, holotype, carapace width 63.0 mm). (*a*) Cephalothorax, dorsal aspect. (*b*) Cephalothorax, frontal aspect, (*c*) Left third maxilliped, part of the sternum, and the whole abdomen of the same specimen, drawn in situ. (*d*) Right chela, lateral aspect. (*e*) Left chela, lateral aspect. (*f*) First right walking leg. Scale bars: *a-c*, 10.0 mm; *d-f*, 20.0 mm.

Colour

Based on living adult specimens of *S. kagoroensis*. Dorsal carapace, postfrontal crest dark brown; flanks paler brown. Branchial regions of carapace marked by distinct pale yellow patches. Third maxillipeds pale brown with purple tinge;

epistome orange-red; cornea black. Sternum pale brown to yellow. Arthrodistal membranes between joints of chelae and pereiopods pale white-yellow. Ventral surface of chelae pale brown to pink-mauve, chela teeth yellow; tips of chelae yellow-cream. Pereiopods uniformly light brown. In life,

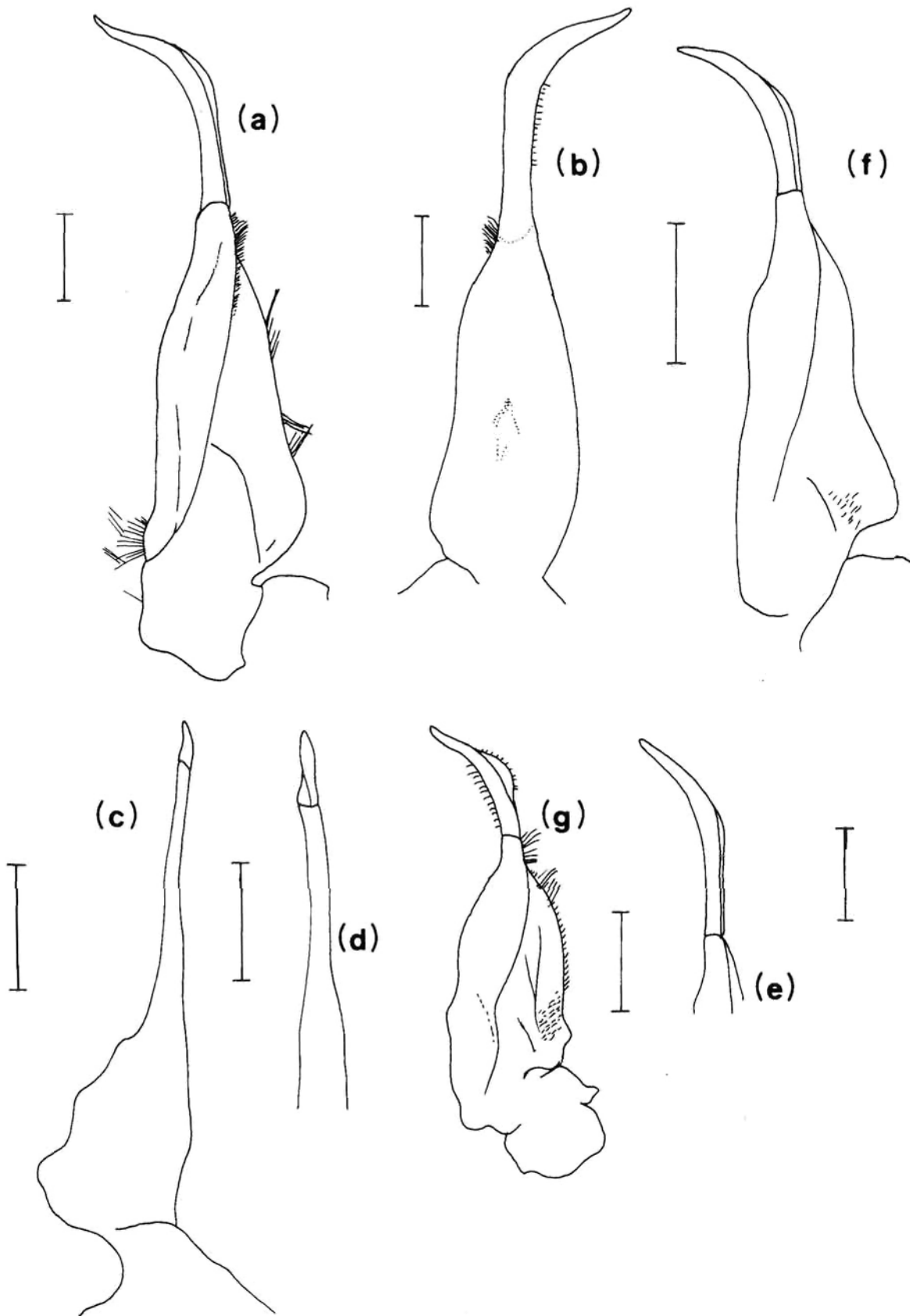


FIG. 2. (a-d) *Sudanonautes kagoroensis* n.sp. from Agban River, Kagoro, Nigeria, male holotype, carapace width 63.0 mm. (a) Right gonopod 1, ventral aspect. (b) Right gonopod 1, dorsal aspect. (c) Right gonopod 2, ventral aspect. (d) Right gonopod 2, detail of end segment. (e) *Sudanonautes kagoroensis* n.sp., end segment of right gonopod 1 of juvenile male (carapace width 31.5 mm). (f) *Sudanonautes orthostylis* (Cumberlidge, 1989) from Ekang, Oban Hills, Nigeria (CW 41.5 mm), right gonopod 1, ventral aspect. (g) *Sudanonautes monodi* (Balss, 1929) from Laro, Cameroon, holotype (CW 55.0 mm), right gonopod 1, ventral aspect. Scale bars: a, b, c, e, and f, 2.0 mm; d, 1.0 mm; g, 4.0 mm.

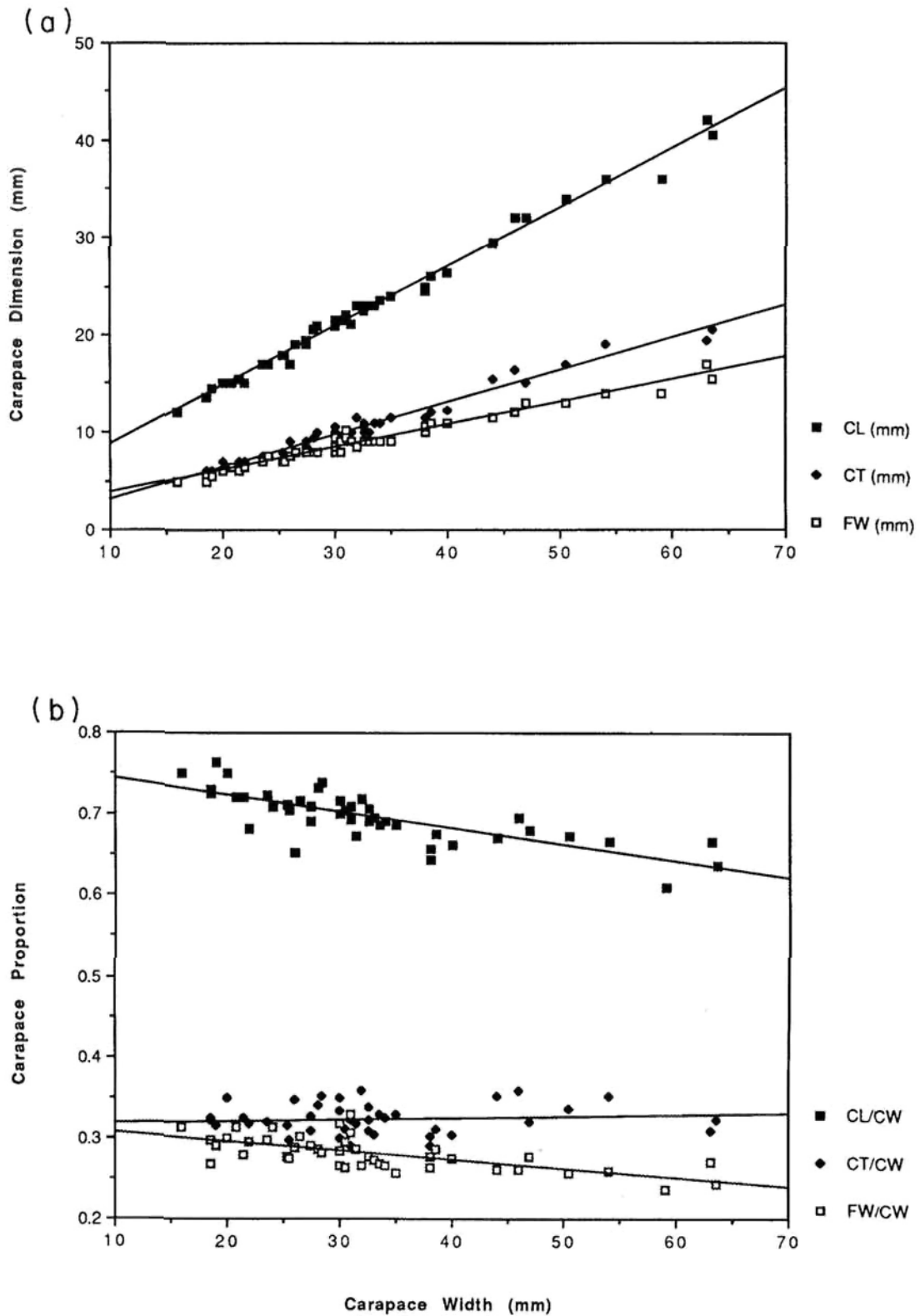


FIG. 3. Comparisons of 45 specimens of *Sudanonautes kagoroensis* n.sp., ranging in size from 20.00 to 63.5 mm, all from Agban River, Kagoro, Nigeria. (a) Dimensions of the carapace (CL, CT, FW) relative to body size (CW). Relationships are described by the following regression equations: $CL = 2.608 + 0.61CW$, $r = 0.994$; $CT = -0.251 + 0.331CW$, $r = 0.984$; $FW = 1.463 + 0.232CW$, $r = 0.982$. All correlation coefficients (r) indicate a highly significant correlation ($P < 0.001$) at 43 degrees of freedom. (b) Relative proportions of the carapace (CL/CW, CT/CW, and FW/CW) compared with body size (CW). The relationships are described by the following regression equations: $CL/CW = 0.765 - 0.002CW$, $r = 0.766$; $CT/CW = 0.316 + 0.0002CW$, $r = 0.118$; $FW/CW = 0.318 - 0.001CW$, $r = 0.653$. The r values for CL/CW and FW/CW indicate a very highly significant correlation ($P < 0.001$) at 43 degrees of freedom. The r values for CT/CW indicate no significant correlation ($P > 0.05$), at 43 degrees of freedom. CW, carapace width at the widest point; CL, carapace length, measured along the median line; CT, cephalothorax thickness, the maximum depth of the cephalothorax; FW, front width, the width of the front measured along the anterior margin.

females and juveniles lack pale yellow patches on dorsal carapace. Specimens preserved in alcohol uniformly light brown, regardless of sex and age.

Distribution

Sudanonautes kagoroensis is locally common in streams and rivers of the guinea savanna zone of west-central Nigeria on the western slopes of the Jos plateau. The species occurs in rivers on the top of the plateau, in the fast-flowing streams that drain the western escarpment, and in rivers close to the western base of the plateau. All seven localities from which *S. kagoroensis* has been collected are associated with the Mada River, which collects water from the Jos plateau and eventually joins the Benue and Niger rivers.

Sudanonautes kagoroensis has not been recorded in collections of freshwater crabs made in other parts of Nigeria. For example, *S. kagoroensis* is not known from the Sudan savanna zone in northern Nigeria (Cumberlidge 1986, 1991). The species is absent from collections made in the Hadejia–Jama'are river basin in Kano State, tributaries of which rise on the eastern escarpment of the Jos plateau and flow northeast into Lake Chad. *Sudanonautes kagoroensis* is also absent from the Sokoto River, tributaries of which rise on the northwest escarpment of the Jos plateau (Cumberlidge 1985a). Furthermore, *S. kagoroensis* has not been recorded from the tropical rain forests of southeast Nigeria, despite regular surveys of the decapod fauna in that area over a number of years (Dr. J. R. Reid, University of Calabar, Nigeria, personal communication; Cumberlidge 1989).

ETYMOLOGY: The species name *kagoroensis* refers to Kagoro, Kaduna State, Nigeria, where the new species was first collected.

Comparisons

Recent descriptions of the six other species of *Sudanonautes* that occur in Nigeria are available elsewhere (Capart 1954; Bott 1955, 1964; Monod 1977, 1980; Cumberlidge 1989, 1991); their resemblances to and differences from *S. kagoroensis* are discussed below.

Sudanonautes kagoroensis most resembles *S. orthostylis*. The carapace of both taxa is smooth, moderately arched, and rounded; the penultimate segment of gonopod 1 of both species is slim and not widened; the end segment of gonopod 1 of both is widened on its medial margin and bears a longitudinal groove (Figs. 2a, 2f). The two species may be distinguished by their overall body size: *S. kagoroensis* is the bigger of the two, and its pubertal moult occurs in a larger size class (CW = 40–50 mm) than that of *S. orthostylis* (CW = 25 mm). The inner margin of the end segment of gonopod 1 of *S. kagoroensis* is widest halfway along the end segment and narrowest near the junction of the two segments (Fig. 2a). The inner margin of the end segment of gonopod 1 of *S. orthostylis*, on the other hand, is narrow along its entire length (Fig. 2f). Finally, the carapace of *S. kagoroensis* is significantly ($P < 0.05$) flatter (CT/CW = 0.322 ± 0.018 , $n = 45$), than that of *S. orthostylis* (CT/CW = 0.366 ± 0.036 , $n = 13$).

Sudanonautes kagoroensis is similar in body size to *S. aubryi*, *S. floweri*, and *S. monodi*, and all have a smooth rounded carapace lacking teeth on the margins. However, *S. kagoroensis* differs from the other three taxa as follows. The inner margin of the end segment of gonopod 1 of *S. kagoroensis* is wider than that in *S. aubryi* and *S. floweri* but is much narrower than in *S. monodi* (Fig. 2g). Furthermore, the carapace, as measured by the relative carapace thickness (CT/CW), is significantly less arched ($P < 0.05$) in *S. kagoroensis* than in *S. aubryi* and

S. floweri (CT/CW = 0.414 ± 0.021 , $n = 15$), and *S. monodi* (CT/CW = 0.389 ± 0.036 , $n = 32$).

Sudanonautes africanus, the type species of the genus, can be distinguished from *S. kagoroensis* as follows. The inner margin of the end segment of gonopod 1 of *S. africanus* is tapering, not widened, and lacks a longitudinal groove; the anterolateral margin of the carapace has a large triangular intermediate tooth rather than a small notch. The carapace of *S. africanus* is significantly flatter ($P < 0.05$) than that of *S. kagoroensis* (CT/CW for *S. africanus* = 0.302 ± 0.022 , $n = 37$) and is rough textured with lateral warty patches in the posterior regions, granulations in the anterior corners, and deep grooves. In contrast, the carapace of *S. kagoroensis* is uniformly smooth textured, and the carapace grooves are not well defined. In addition, *S. africanus* is by far the larger species, growing to a CW of 110.0 mm, with a pubertal moult between CW = 70 and 90.0 mm, sizes at which all *S. kagoroensis* would be fully mature. Finally, the two species appear to be ecologically distinct, for *S. africanus* occurs in tropical rain forest and *S. kagoroensis* in guinea savanna.

Sudanonautes kagoroensis shares some features with *S. pelii*: both species are medium sized, have a smooth carapace, show a similar degree of carapace arching, and occur in the guinea savanna zone of Nigeria. *Sudanonautes kagoroensis* can be distinguished easily from *S. pelii* by the following characters. The carapace of *S. kagoroensis* is significantly flatter ($P < 0.05$) than that of *S. pelii* (CT/CW for *S. pelii* = 0.386 ± 0.031 , $n = 53$). The end segment of gonopod 1 of *S. pelii* is rounded and evenly tapered, and lacks the longitudinal groove; the intermediate tooth on the anterolateral margin of the carapace is large and triangular, not a small notch, and the postfrontal crest meets the anterolateral margin behind, and not at the epibranchial tooth.

The colour of live specimens offers another means of distinguishing between the species of *Sudanonautes* in the field. The dorsal carapace of adult male *S. kagoroensis* is dark brown with dull yellow patches, and the postfrontal crest is also dark brown. Colour clearly distinguishes this species from *S. aubryi*, *S. floweri*, and *S. monodi*, whose carapaces are uniformly red-brown with a contrasting yellow postfrontal crest. Both *S. kagoroensis* and *S. orthostylis* have dark carapaces, but the two taxa can be distinguished by the colour of the chelipeds, which are brick-red to yellow in *S. orthostylis*. The colour of the arthrodistal membranes between the sternum and coxae of the legs, and between the dactylus and the index of the chelipeds, is another feature that distinguishes the species of *Sudanonautes*. In *S. kagoroensis* these membranes are brown–yellow, whereas in *S. orthostylis* they are brick-red to yellow. *Sudanonautes kagoroensis* can be also distinguished from *S. africanus* and *S. pelii* by the colour of the carapace and the arthrodistal membranes. The carapace of both *S. africanus* and *S. pelii* is uniformly dark green–brown, and lacks the patches of yellow seen in *S. kagoroensis*, while the arthrodistal membranes of *S. pelii* and *S. africanus* are crimson.

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