

FIGURE 48.—*Atya scabra* (from male from São Tiago, Cape Verde Islands): *a*, dorsal view of cephalic region; *b*, mesial view of appendices masculina and interna; *c*, lateral view of cephalic region; *d*, lateral view of second through fifth abdominal pleura; *e*, lateral view of preanal carina; *f*, lateral view of third pereiopod; *g*, dorsal view of telson; *h*, flexor surface of distal part of third pereiopod. (Scales marked in 1 mm increments.)

fee (Rathbun, 1900:313), 1♂ (17.3), 22 Mar 1897, R.P. Currie. (2) †BM, St. Paul River near Handi (6°54'N, 10°22'W), 1♀ (24.3), 6 Mar 1970, R. Garms. (3) *RNHL, Sheffelinville between Monrovia and Marshall (Holthuis, 1966:235), 1♂ (12.2), 1887, J. Büttikofer. (4) †BM, Cavalla River near Nyaake, Grand Gedeh Co (4°51'N, 7°35'W), 1♂ (23.1), 13 Dec 1970, R.G. (5) †USNM, Liberia Harbel, 64 km inland from Monrovia, 1♀ (17.7), "Smithsonian Firestone Exped. to Liberia." (6) †USNM, Cavalla River at Bolobo, 2♂ (20.1, 23.3), 1♀ (10.2), H.A. Beatty.

GHANA: (1) Environs of Cape Coast between Elmina and Anomabu (Rutherford, 1971:87, 88).

CAMEROON: (1) "Etome in Bächen" (Aurivillius, 1898:16). (2) Victoria (Balss, 1925:239). (3) Bimbria River near Dikullu (Monod, 1928:121; 1933:462). (4) stream near Tiko (Monod, 1933:462). (5) Kienke River near Kribi (Monod, 1933:462), (6) †RNHL, about 3 km N of Kribi, 1 juv (3.9), 5 Aug 1964, B. de Wilde-Duyfjes. (7) *RNHL, pools and waterfalls of the Lobé River about 9.0 km S of Kribi (Holthuis, 1966:235), 5♂ (6.2–8.9), 6♀ (5.1–9.8), 3 ovig ♀ (7.1–8.8), 23 juv

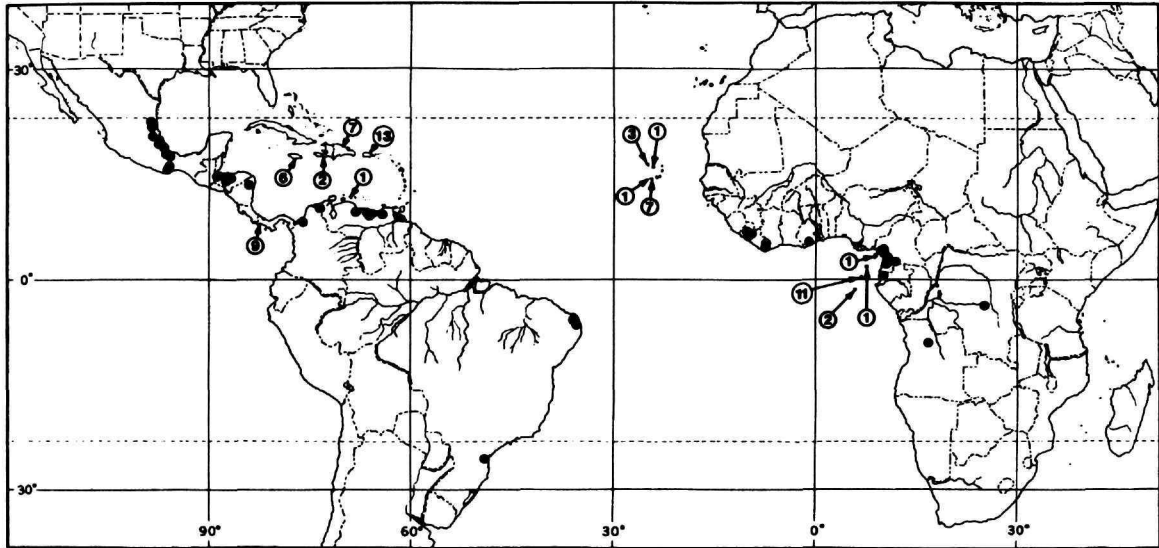


FIGURE 49.—Distribution of *Atya scabra* (circled numerals = number of localities; see Figures 50–52).



FIGURE 50.—Distribution of *Atya scabra* in Costa Rica and Panama.

(2.7–4.8), 7 Aug 1964, BWD; 5 juv (2.5–2.7) 9 Aug 1964, BWD. (8) †RNHL, Kribi, caught by fishermen with beach seine, 3 juv (2.8–3.0), 9 Aug 1964, BWD. (9) †BM, Bille River, 1♂ (18.4), 19

May 1969, R.L.H. Disney. (10) †BM, Blackwater River (4°22'N, 9°47'E), 1♂ (20.7), 19 Nov 1968, RLHD; 1♂ (21.8), 13 Feb 1969, RLHD.

GABON: †RNHL, Gabon River at Orurendo Point, 1♀ (16.3), 27 Aug 1956, J.H. Logemann.

ZAIRE: “MBuma dans le Mayumbe” (De Man, 1925:27, 28), 1♂ (80, t.l.), 25–26 Oct 1920, Dr. Schouteden.

NORTH ANGOLA: Duque de Bragança (Osorio, 1887:230).

CAPE VERDE ISLANDS: (White, 1847:74). *MHNP (Bouvier, 1904:138), 1 ovig ♀ (23.7), 1866. *BM, 1 dry specimen (22.3); 9♂ (12.0–17.3), 1♀ (18.6); *BM, 1♂ (28.1), *Challenger*. *Santo Antão*—(1) *RNHL, Ribeira de Paul (Holthuis, 1966:234), 3♂ (13.5–23.7), 1 ovig ♀ (14.0), May 1950, J. Cadenat. (2) *RNHL, Ribeira Grande (Holthuis, 1966:234), 1♂ (14.4), 1♀ (9.0), 27–28 Dec 1953, H. Lindberg. (3) *MHNP, no locality (Bouvier, 1904:138), 3♂ (21.5–28.5), 1♀ (15.9), 2 ovig ♀ (15.2, 17.8), 1900, A. de Cessac. *São Nicolau*—(Newport, 1847:159). (1) Ribeira Brava (Osorio, 1905:102). (2) *RNHL, Cha da Prequiça (Holthuis, 1966:235), 1 juv (3.9), 13–17 Dec 1953, HL. *Brava*—*RNHL, Faja Agua (Holthuis, 1966:235), 3 juv (3.4–7.1) 5 Feb 1954, HL. *São Tiago*—(1)

São Antonio Valley (Bate, 1888:694). (2) †BM, Ribeira Picos, 8♂ (13.9–23.3), 1♀ (12.9), C. Stoner; 36♂ (14.6–25.3), 6♀ (11.5–16.6), CS. (3) †USNM, river, 4♂ (19.7–24.9), CS. (4) †MHNP, Ruisseaux descendant de Pics de Antonia au dessus de 500 m alt, 11♂ (19.6–34.4), 1♀ (13.9), 10 ovig ♀ (15.9–20.3), A. Chevalier. (5) *RNHL, Lagoa

(Holthuis, 1966:235), 4♂ (12.1–17.1), 15 Feb 1954, HL. (6) *RNHL, Praia (Holthuis, 1966:235), 20 juv (2.9–4.9), 5–19 Feb 1954, HL. (7) *RNHL, Ribeira Picos, near Picos (Holthuis, 1966:235), 8♂ (6.6–24.8), 12♀ (6.0–14.3), June 1950, JC.

FERNANDO POO: (Bouvier, 1904:138). *BM, 3♂ (10.1–14.4), 3♀ (7.0–10.0), 1 ovig ♀ (13.5).

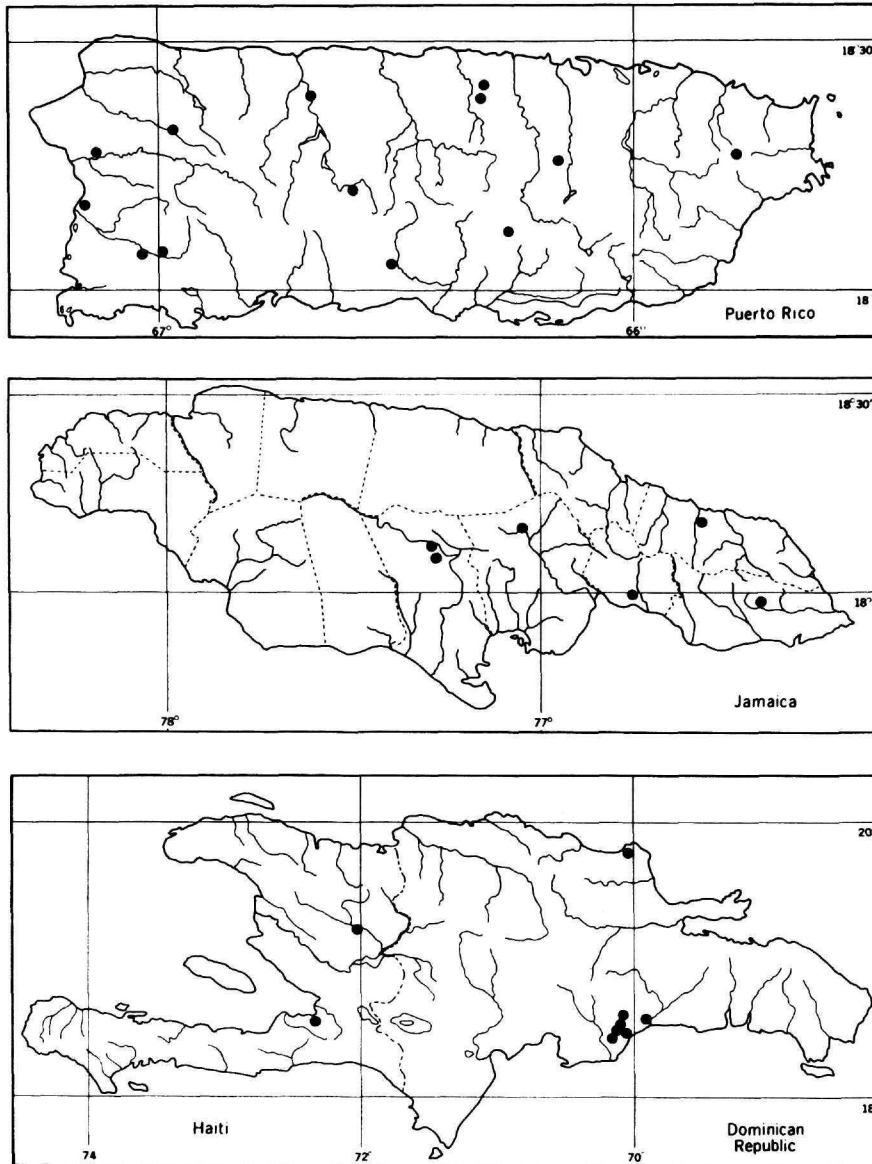


FIGURE 51.—Distribution of *Atya scabra* in the Greater Antilles.

IHLA DO PRINCIPE: (Osorio, 1898:194). (1) Rio Papagaio (Osorio, 1889:139). (2) Rio Banzu (Osorio, 1895b:251).

SÃO TOMÉ: (Greeff, 1882:35). (1) Rivière Agua Grande (Osorio, 1887:222). (2) Batipa (Osorio, 1889:137). (3) Obó Vermelho (Osorio, 1889:137). (4) Rio Quija (Osorio, 1891a:47). (5) Fleuve Manuel Jorge (Osorio, 1891b:140). (6) Rio Gumoela (Osorio, 1892:200). (7) Portinho (Osorio, 1892:200). (8) Rio Agua Izé (Osorio, 1906:150). (9) *RNHL, Bombom (Holthuis, 1966:235), 1♂ (18.1), 1♀ (13.3). (10) *MHNP, A. Negreiros (Bouvier, 1925:316), 1♂ (20.3), 1900. (11) †MHNP, Rio de Ouro, 1 ovig ♀, 24 Jul 1906.

ANNOBÓN: (Osorio, 1898:194). (1) Rio São João (Osorio, 1895a:249). (2) *RNHL, Crater Lake (Balss, 1914:97), effluent from (01°25'S, 05°36'E), 55♂ (7.0–25.1), 28♀ (6.1–11.2), 16 ovig ♀ (7.2–16.7), 20 Mar 1965, Pillsbury sta 278; USNM, 3♂ (9.0–21.1), 1♀ (8.8), 2 ovig ♀ (11.0, 19.6).

CUBA: (Martens, 1872:135). (1) Río Almendares at Calabazar, Provincia de la Habana (Bouvier, 1925:317); *USNM, 3♂ (8.0–19.2), C.F. Baker. (2) Calabazar, Provincia de la Habana (Bouvier, 1909:333). (3) †MHNP, La Habana, Provincia de la Habana, 4♂ (11.8–17.7), 1♀ (12.1), 1909. (4) Río San Vicente near Viñales, Provincia de Pinar del Río (Holthuis, 1974:231).

JAMAICA: (Ortmann, 1895:410, in error for Newport's *Atya occidentalis*). *USNM, 2♀ (20.9, 21.0), 1–11 Mar 1884, *Albatross*. (1) Thomas River 1 mi N of Summerfield, Clarendon Pr (Hart, 1961b:64). (2) *RNHL, Río Minho at confluence with Pennants River, Clarendon Pr (Hart, 1961b:64), 2♂ (23.5, 26.8), 9 Apr 1959, C.W. Hart. (3) *USNM, Byndloss Gully, 1.5 mi N of Linstead on road to Ewarton, St. Catherine Pr (Hart, 1961b:66), 4♂ (18.0–26.2), 1♀ (18.2), 7 Apr 1959, G. Thomas, CWH. (4) Cane River, St. Andrew Pr (Hunte, 1978:142). (5) Morant River, St. Thomas Pr (Hunte, 1978:142). (6) Bugaboo River, St. Thomas Pr (Hunte, 1978:142). (7) Swift River, Portland Pr, alt 80 m (Hunte, 1978:142).

HISPANIOLA: *Haiti*—(Kingsley, 1878a:92). (1) †BM, Hinche, 2♂ (20.4, 30.1), I. Sanderson. (2)

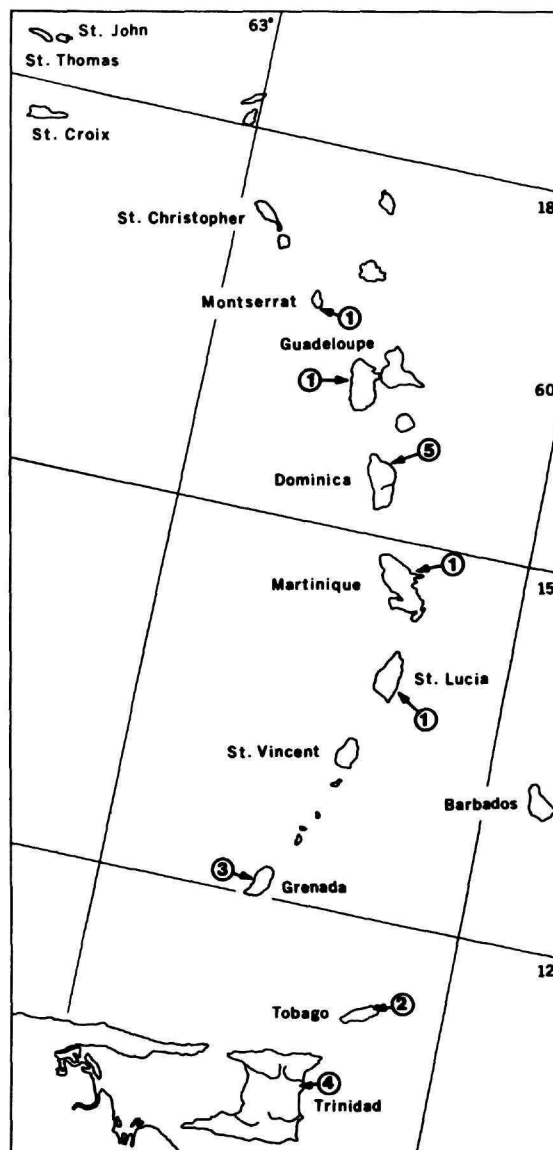


FIGURE 52.—Distribution of *Atya scabra* in the Lesser Antilles (circled numerals = number of localities).

†BM, Thorlands, 1♂ (18.0), 1♀ (18.9), 2 ovig ♀ (12.4, 16.3), 17 May 1937, IS. *Dominican Republic*—(1) *USNM, "San Domingo," 1♂ (16.0), 1878, W.M. Gabb. (2) Río Haina (Bonnelly de Calventi et al., 1973:1338), 1♂ (30.5), I. Bonnelly de Calventi. (3) *MCZ, Río Nigua (Bonnelly de Calventi et al., 1973:1338) near San Cristóbal, Tru-

jillo Pr, 5♂ (14.2–18.2), 3♀ (10.2–11.5), 5 ovig ♀ (10.1–11.3), P.J. Bermúdez. (4) †USNM, Río San Juan, 1♂ (9.6), S.G. Miller, Jr. (5) Río Mana (Bonnely de Calventi et al., 1973:1338). (6) Cañada Madrigal (Bonnely de Calventi et al., 1973:1338). (7) Río Isa (Bonnely de Calventi et al., 1973:1338). (8) Río Jura (Bonnely de Calventi, 1974a:16). (9) Río Nizao (Bonnely de Calventi, 1974a:16).

PUERTO RICO: *USNM, San Juan Market (Gundlach, 1887:131), 1♂ (18.5), 14 Jan 1899. (2) *USNM, falls of Río Grande de Aibonito (Rathbun, 1901:119), 1♂ (22.9), 26 Jan 1899, *Fish Hawk*. (3) Falls of Río Grande de Arecibo (Rathbun, 1901:119). (4) El Yunque (Rathbun, 1901:119). (5) Trib to Río Añasco (Rathbun, 1901:119). (6) Río Espíritu Santo at El Verde (Villamil and Clements, 1976:5). (7) †USNM, Maricao, creek below town, 3♀ (11.0–12.5), 7 Feb 1934, S.F. Hildebrand. (8) †USNM, Río Maricao, 2♂ (28.0, 29.8), 1♀ (14.4), 9 Feb 1951, N.T. Mattox. (9) †USNM, (?) Maricao, Río Grande de Añasco, 1♂ (about 20), 21 Feb 1934, SFH. (10) †USNM, Juana Díaz, 8♂ (24.4–33.3), 1♀ (15.1), 26 Feb 1934, SFH. (11) †USNM, Río Comerío above S dam, 5♂ (36.5–40.9), 6 Mar 1934, SFH. (12) USNM, Río Culebrinas at Rte 13, 100 m S and 300 m E of San Sebastián, 4♂ (18.0–26.4), 2 Jun 1953, H.W. Harry. (13) †USNM, Río Cruces at Rte 2, 1500 m W of Sabana Grande, 2♂ (18.4, 22.7), 16 Jun 1953, HWH. (14) †USNM, Mayagüez, 1 ovig ♀ (13.3), 20 Jan 1899, *Fish Hawk*. (15) †USNM, Río Guanajibo, about 2,000 m E of San Germán, 1♂ (22.6), 16 Jun 1953, HWH. (16) †USNM, stream at Jayuya, 1♂ (42.2), Spring 1954, L.A. Costas.

SAINT KITTS: †RNHL, Wingfield, 5 juv (3.2–3.5), 30 Jun 1949, P.W. Hummelinck.

MONSERRAT: †BM, river at Monserrat, 4♂ (20.4–26.1), 1♀ (21.0), 2 ovig ♀ (16.4, 19.8), F.H. Mansell.

GADELOUPE: Rivière Bras David (Lévêque, 1974:42).

DOMINICA: (Oliviera, 1945:177). *USNM, 2♂ (17.5, 22.3), 1♀ (18.0). (1) *USNM, trib to Layou River across from Clarke Hall (Chace and Hobbs, 1969:66), 1♂ (20.1), 4 Feb 1964, HHH. (2)

*USNM, Mannet's Gutter near mouth (Chace and Hobbs, 1969:66), 1♂ (27.8), 1 Apr 1964, HHH; 1♂ (23.4), 19 Feb 1966, HHH; 2♂ (22.1, 23.6), 1♀ (15.6), 21 Feb 1966, HHH. (3) *USNM, Mannet's Gutter at upper bridge (Chace and Hobbs, 1969:66), 1♂ (21.1), 13 May 1966, Nichols and Oliver. (4) *USNM, Fond Figue River (to Castle Bruce River) (Chace and Hobbs, 1969:66), 1♂ (11.5) 22 Mar 1964, HHH. (5) *USNM, Pichelín River below Logge (to Stewart's River) (Chace and Hobbs, 1969:66), 1♂ (31.2), 26 Mar 1964, CWH, HHH.

MARTINIQUE: (Sharp, 1893:111). †MHNP, La Trinité, 3♂ (27.4–37.5), 2♀ (17.0, 18.8), 1 ovig ♀ (17.2), 1916.

SAINT LUCIA ISLAND: †BM, Marc Stream, 2 ovig ♀ (11.4, 12.1), 18 Jun 1971, G. Barnish and R.F. Sturrock.

GRENADA: (1) †RNHL, La Sagesse River, Coats Gap, St. Davids, 1 ovig ♀ (17.9), 9 Jan 1966, Justin Francis. (2) †RNHL, Beaulieu, 1 ovig ♀ (16.9), 3 Oct 1965, J.R. Groome. (3) †RNHL, St. Marks River, Bonaire Estate, 1♂ (11.5), 25 Jan 1966, C.A.O. Philips.

TOBAGO: (Ortmann, 1895:410). *BM, 2♂ (13.4, 14.9), 1 ovig ♀ (11.0), P.L. Guppy. (1) †RNHL, Frenchman's River at Speyside, 1♂ (17.3), 1♀ (10.1), 1 ovig ♀ (11.5), 18 Jan 1955, PWH.

TRINIDAD: *BM, 2♂ (34.0, 40.0), PLG. (1) *MHNP, Port of Spain (Bouvier, 1925:316), 1♂ (31.8), 1♀ (22.0), 1914, Paul Serre. (2) †MCZ, brook at Maguerepe Bay, 1♂ (18.0), 7 ovig ♀ (10.4–13.2), 24 Jul 1937, E. Deichmann. (3) †BM, Mt. Aripo, in small, clear, rocky river, 1♂ (16.1), 1♀ (20.0), 10 Aug 1937, IS. (4) †BM, Maracas River, 4♂ (26.1–35.2), 1♀ (19.5), 2 ovig ♀ (18.6, 20.3).

CURAÇAO: †RNHL, Santa Cruz Plantation near Santa Cruz, 1♀ (9.7), 1 ovig ♀ (11.0), 11 Jan 1957, L.B. Holthuis.

MEXICO: (Guérin-Méneville, 1829–1844:15). *RNHL, 2 dry spec (29.5, 34.8). *USNM, 1♂ (35.1). *Tamaulipas*—(1) †MCZ, Río Frío, 16 km N of Mante, 2♂ (15.0, 18.3), 21 Dec 1939, W.A. McLane. (2) *USNM, Río Sabinas (to Río Tamesí) at Storm's Ranch, km 619 Carretera Interamericana, 4.8 km NE of Gómez Farías (Darnell,

1956:131), 3♂ (22.7–25.5), 1 ovig ♀ (16.2), 27 Apr 1950, M. Darnell. *Veracruz*—(1) †USNM, Santa María, 2♂ (18.0, 19.5), 14 Feb, Nelson and Goldman. (2) †USNM, Orizaba, 1 ovig ♀ (14.4). (3) *BM, Misantla (Wiegmann, 1836:145), 3♂ (21.9–29.8), 1 ovig ♀ (18.6), 1888, F.D. Godman. (4) Río Necaxa near Coyutla (Villalobos, 1943:11). (5) Río Papaloapan (Villalobos, 1959:328). (6) Tapalapan, Santiago Tuxtla (Hobbs, 1971:27). (7) †BM, Hacienda El Hobo, Río de los Bobos, 1♂ (16.6), 1 ovig ♀ (21.1), Nov 1897, P. Geddes. *Oaxaca*—(1) *MHNP, Río Chacalapa near Pochutla (Bouvier, 1925:316), 1♂ (22.3), 1903, Diguët. (2) *MHNP, Valle Nacional (Bouvier, 1904:138), 3♂ (23.6–25.5), 4♀ (20.1–21.4).

GUATEMALA: (1) *USNM, Río Gualán at Gualán (Bouvier, 1925:317), 3♂ (17.5–33.5), 1♀ (20.0), 1 ovig ♀ (injured), 4 Jun 1909, C.C. Dean. (2) †RNHL, in drinking water on KNSM ship *Breda*, water last filled at Puerto Barrios, 1 juv (3.0), March 1966, J. Geyskes.

HONDURAS: (1) †USNM, Lancetilla, 1♂ (21.1), 14 May 1946, A.F. Carr, Jr. (2) †USNM, Río Guayabal, trib to Río Comayagua, Dept de Cortés, alt about 100 m, 2♂ (28.9, 33.3), 22 May 1948, A.C. Chable. (3) †USNM, Lago de Yojoa, 1♂ (32.2), 7 Nov 1954, S.Y. Lin, Jr.

NICARAGUA: †USNM, Waspuc River at Musawas, 3♂ (20.0–32.5), 2 ovig ♀ (13.5, 16.7), Oct 1955, B. Malkin.

COSTA RICA: †BM, Salamanca, 1♂ (20.1), March 1895, HP.

PANAMA: *LGA, 9♂ (14.1–23.9). (1) Atlantic side (Doflein, 1900:127). (2) *USNM, Río Chagres Basin, Isla Barro Colorado (Allee and Torvik, 1927:67), 8♂ (6.2–15.0), 20 ovig ♀ (9.2–11.4), Aug 1962, H. Loftin. (3) †USNM, large river on mainland opposite Isla Multatupo, 6♂ (6.0–14.1), 4♀ (5.0–9.8), 1 ovig ♀ (9.4), 2 Dec 1962. (4) †USNM, San Blas area, creek just W of Puerto Obaldía, 7♂ (6.5–8.2), 4 ovig ♀ (10.1–10.4), 9 Feb 1963, HL. (5) †USNM, San Blas area, small river opposite Isla Ustupo (Portogandí), 1♂ (10.8), 1♀ (11.6), 1 ovig ♀ (9.3). (6) †USNM, Chiriquicito, backwaters and banks of Río Guarumo, 2♂ (16.8, 18.3), 1♀ (15.4), 3 ovig ♀ (9.2–13.7),

18 Apr 1963, HL. (7) †USNM, Río Lagarto between La Campana and Bejuco, 2♂ (9.6, 12.2), 2♀ (8.4), 1 ovig ♀ (9.5). (8) †LGA, "Atlantic Pipeline Road," 2♂ (28.6, 31.4), 1973, L.G. Abele and Robinson. (9) †LGA, stream 20–23 km N of El Llano on Cartí Hwy, 1♂ (11.3), 30 Mar 1973, R.L. Dressler. (10) †LGA, Río Frijoles, 1♀ (19.1), 14 May 1975, Kramer; 1♂ (25.1) Aug 1974.

COLOMBIA: (1) Río Carabali, affluent of Río Chagri, Darién (Bouvier, 1904:138). (2) Santa Marta (Pearse, 1915:551).

VENEZUELA: (1) Río Macuto near La Guaira (Nobili, 1897:5). (2) †USNM, freshwater rocky branch at Macuto (cited by Rathbun, 1901:119, as "Venezuela"), 5♂ (13.5–25.1), 1 Aug 1900, Lyon and Robinson. (3) San Esteban (Bouvier, 1904:138). (4) *MHNP, Naricual (Bouvier, 1904:138), 5♂ (20.0–24.3), 1♀ (15.6), 1 ovig ♀ (20.8), 1885. (5) †RNHL, Río Tuy, Santa Teresa del Tuy, Estado de Miranda, 1♀ (18.6), Feb 1949, G. Marcuzzi. (6) †USNM, Río Cumboto near mouth, 2 km NW of Ocumare, 1♂ (7.3), 5 May 1939, F.F. Bond. (7) Río Manzanares, Cumaná, Estado de Sucre (Davant, 1963:100).

BRAZIL: (1) Rio Prangí, Estado do Pernambuco (Oliveira, 1945:177). (2) Rio Serinhaem, Estado do Pernambuco (Lemos de Castro, 1962:50). (3) †USNM, Blumenau, Estado do Santa Catarina, 1♂ (46.3), 1 ovig ♀ (29.5), Feb 1926, Paula Paul.

ERRONEOUS OR PROBABLY ERRONEOUS LOCALITIES.—There is reason to question the following localities as noted for each.

AUSTRALIA: Victoria (Bouvier, 1904:138). Two specimens reported by Bouvier, if correctly identified, almost certainly bore erroneous data, for no member of the genus, as defined herein, has since been reported from the continent.

NEW CALEDONIA: (Ortmann, 1890:465). The three syntypes of *Atya margaritacea* A. Milne-Edwards (1864), considered by Ortmann to belong to *A. scabra*, constitute the basis for this erroneous record. As pointed out elsewhere, that the specimens were collected on New Caledonia is highly improbable.

ROLAS ISLAND: (Rathbun, 1900:314). Apparently Rathbun erred in recording Rolas Island as having been cited to be frequented by *A. scabra*

by Greeff, and her error was repeated by Balss (1914:98).

BAJA CALIFORNIA: (Holthuis, 1951:25). Considering *Atya rivalis* (= *A. margaritacea*) to be a synonym of *A. scabra*, Holthuis cited Lower California as marking the northern limit of the range of the latter on the west coast of the Americas.

WESTERN MEXICO: (Stimpson, 1857:498). We have not located the specimens in the Smithsonian collections on which Stimpson based this record. Perhaps it is a valid one, for the lot cited here from Río Chacalapa, Oaxaca, contains a male of this species rather than one of *A. margaritacea* as we had anticipated.

NICARAGUA: (Rathbun, 1900:313). The Nicaraguan record was based upon the assumed synonymy of *A. rivalis* with *A. scabra*. The types of the former were from Nicaragua. A new locality on the eastern versant (see above) has established the presence of *A. scabra* in the country.

COSTA RICA: (Rathbun, 1900:313). The locality record for Costa Rica by Rathbun, and elaborated upon by Bouvier (1925:316), was based on a collection of *A. margaritacea* from Río Platanales, Mt. Chiriquí, which is in Panama. To our knowledge, the first valid record of the occurrence of the species in this country is the new one cited herein.

VENEZUELA: (Rathbun, 1900:313). Rathbun's recording the presence of *A. scabra* in the Orinoco was based on the assumed synonymy of Koelbel's *A. sculptilis* (= *A. gabonensis*) from the Orinoco River with *A. scabra*. Apparently she was unaware of the locality "Río de Macuto" that had been reported by Nobili (1897:5).

ARGENTINA: †BM, Buenos Aires, 1♂ (22.5), Mar 1892, H.P. Hirt. Within the lot containing this specimen of *A. scabra* were two specimens of *A. margaritacea*. Inasmuch as the latter has been found elsewhere only in the Pacific watershed and has not been collected in other localities with *A. scabra*, the source of the specimens contained in this lot must be questioned.

VARIATIONS.—Try as we may, we have found no character or group of characters that enable us to distinguish the African *Atya sulcatipes*, *A. margaritacea* var. *claviger*, and the American *A.*

punctata from the insular and continental American *Atya scabra* (including *A. mexicana*). Furthermore, the nature of the variations that have been reported to serve as a means of separating them, even were they reliable, seems to us to be so minor that they are hardly noteworthy. Most of the specimens that we have examined from Africa and the eastern Atlantic islands lack corneous denticles on the ventral margin of the second abdominal pleuron, but individuals in several lots possess one or more of them. The reverse is true of specimens from the Americas (including the West Indies). Comparisons of proportions of several features of the antennules and pereopods resulted in the discovery of no feature that could be associated with a restricted part of the range.

The setal pile so conspicuous in recently molted individuals is sometimes exceedingly sparse. The rostral margins may be subparallel or rather strongly concave; the dorsal carina varies from being moderately high and rounded to high and sharp and frequently concave, sloping over the main body of the rostrum to the level of the lateral carinae; toward the apex, it may be smooth or scalloped but terminates at, or almost at, the tip of the acumen. The width and depth of the furrows flanking the median carina are also quite variable but, in general, are rather broad and shallow in small individuals, becoming deeper and the fundal area narrower (as a result of thickening of the basal parts of the lateral and median carinae) in larger, presumably older, individuals. The ventral carina may bear one or no spine along the anterior half.

The width of the penultimate podomere of the antennule ranges from only slightly less than the length to a little less than half as long. The basal podomere of that appendage bears none to three corneous spinules dorsally, and the premarginal spinules on the dorsal surface of the penultimate and ultimate podomeres vary both in number and position, the more laterally situated ones on the penultimate segment sometimes occurring in a linear series.

The merus of the third pereopod ranges from about 2.0 to 2.7 times as long as high; the pattern of distribution of the tubercles on its lateral sur-

face follows somewhat that illustrated in Figures 45j, 46f, 48f, but the details are apparently never identical. In small individuals, a single ventrolateral spine occurs near the distal end of the podomere but is absent or reduced to a vestige in virtually all individuals with a carapace length greater than 20 mm. Whereas the number of tubercles on the flexor surface of the propodus of the third pereopod may vary, some of those forming the row on the mesial side of the median line are contiguous or overlap (Figures 45l, 46h, 48h, 53). The spines on the merus and carpus of the ambulatory appendages in many, if not most, individuals with carapace lengths under 20 mm are dispersed as follows: the merus of the third pereopod exhibits one distal ventrolateral spine, and the carpus lacks spines; the merus of the fourth pereopod possesses in addition to one spine corresponding to that on the third another proximoventral to it, and the carpus bears one distal ventrolateral spine; the spination of the fifth pereopod differs from that of the fourth in the presence of an additional spine on the ventral surface of the merus. Whereas spines are lacking on the third pereopod in virtually all individuals with a carapace length of as much as 20 mm (and in some others that are smaller), in the largest specimen available the distolateral one is present on both the merus and carpus of the fourth and fifth; in some of the larger individuals, at least one of the ventral spines is present on the merus of the fifth, and in some individuals two are present on the merus of both the fourth and fifth legs.

ECOLOGICAL NOTES.—Ten years after this shrimp had been described from an unknown locality, Guilding (1825:338) reported its occurrence “in incredible numbers in the mountain streams” of Saint Vincent. As expressed in the “Review of Literature” above, Guilding probably did not distinguish this shrimp from the more commonly occurring *Atya innocous*. Newport (1847:159) noted that *Atya sulcatipes* had been found “300 feet above the level of the sea on San Nicolas, Cape Verde Islands.” The reported occurrence of members of the species from “les côtes du Mexique” by Guérin-Méneville (1829–

1844:15), H. Milne Edwards (1837:348), and others apparently gave some subsequent authors the impression that *A. scabra* occurred in salt water, for Stimpson (1857:498) stated that “Milne-Edwards considers *A. scabra* to be a marine form, but there is great doubt that any species of the genus is found in the sea.” Gundlach (1887:131) found this shrimp in a tributary to Río Añasco in the interior of Puerto Rico. Osorio (1887–1906) reported its occurrence in several streams in the Cape Verde Islands and on other islands off the West African coast at altitudes of 200 (1892:200) to 300 m (1891b:140). Rathbun (1897:44) reiterated its presence in “Fresh waters of tropical America and Cape Verde Islands,” and Aurivillius (1898:16) reported his *Atya margaritacea* var. *claviger* from “brooks.” Pearse (1915:551) noted that in the area of Colombia in which he was exploring, “This peculiar shrimp was quite common in the swift streams flowing among bowlders [sic] over sandy bottoms near ‘La Rosa.’ It was found among or under bunches of dead leaves which had accumulated against sticks or stones.”

Allee and Torvik (1927:67) stated that in Shannon Creek on Isla Barro Colorado, *A. scabra* was limited to the lower 24 pools. Villalobos (1943:11), in describing the locality on the Necaxa River from which his specimens were obtained, stated that it was situated 100 km from the sea, at an elevation of about 800 m in a tropical area surrounded by mountains. The stream at this site is shallow, and the shrimp live under the rocks in places where there are riffles. A collection made in this locality with a U-shaped net placed below the rocks as they were turned yielded 127 specimens in less than a half hour. Darnell (1956) conducted a populational study of *A. scabra* in Tamaulipas, Mexico. In describing the locality (pp. 131–132), he stated:

The habitat of the shrimp was a turbulent riffle, 0–1 meter in depth, with a rock and boulder bottom. . . . Filamentous algae (*Lyngbya* and *Oscillatoria*) made up the only endogenous vegetation. This, however, constituted less than 5 percent of the total vegetation in the riffle, the remainder being composed of exogenous river borne branches, twigs, leaves, and seedpods. Vegetation from the two sources together amounted to 45.1 grams per square meter of riffle bottom.

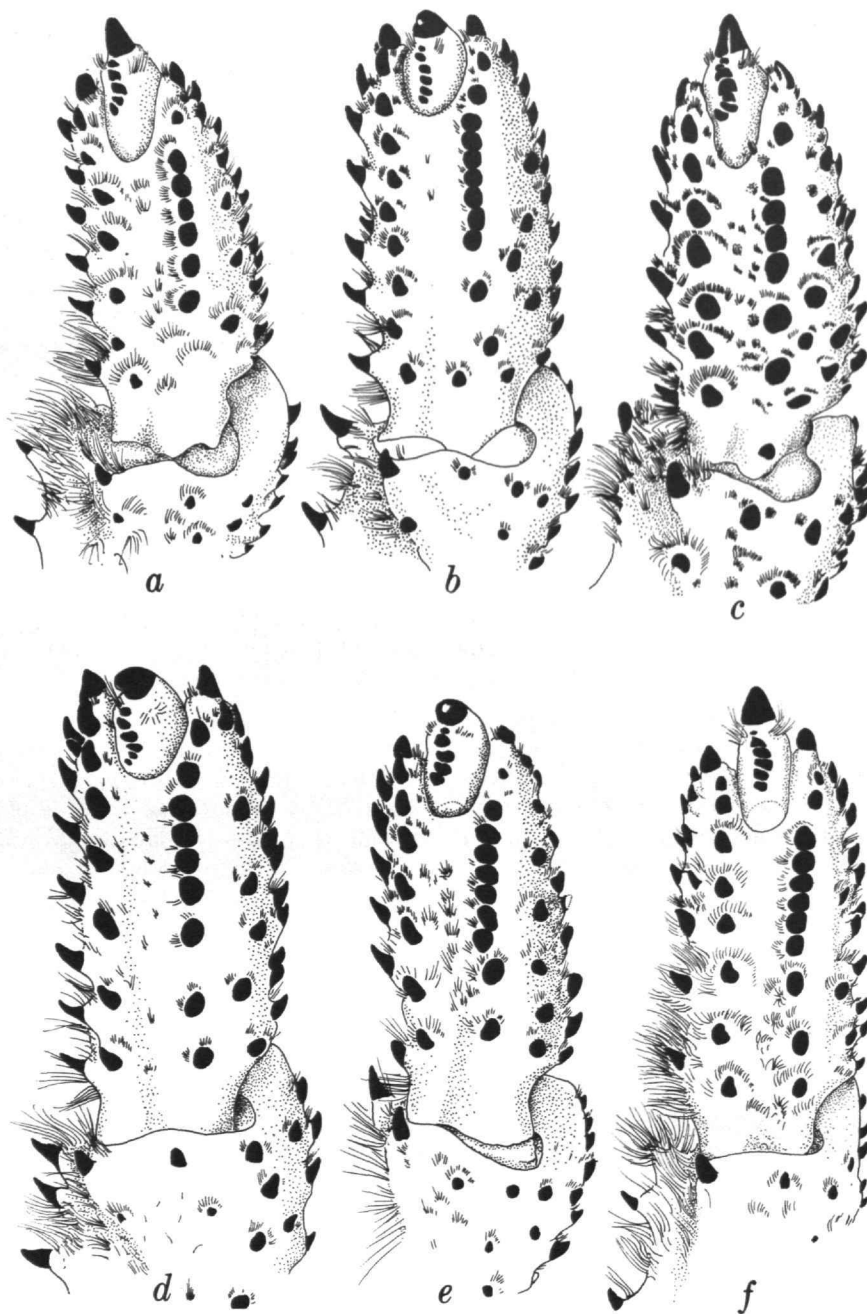


FIGURE 53.—*Atya scabra*, variations in flexor surface of distal part of third pereiopod (numbers in parentheses = carapace length in mm): *a*, Cavalla River, Liberia (♂, 23.1); *b*, Río Haina, Dominican Republic (♂, 30.5); *c*, Río Culebrinas, Puerto Rico (♂, 27.3); *d*, Lago de Yojoa, Honduras (♂, 32.2); *e*, Macuto, Venezuela (♂, 25.1); *f*, Blumenau Estate, Estado do Santa Catarina, Brazil (♂, 46.3).

In addition to the shrimp, an abundant and varied gastropod and insect fauna was present. . . .

Throughout six discontinuous months of field work during the winter, spring, and early summer no specimens of this shrimp were observed outside the riffle during daylight hours. At night, however, they were occasionally noted on rocky bottoms in adjacent shallow backwaters, particularly in the vicinity of weed beds.

Juveniles and some adult females were found along the edges of the riffle. An examination of stomach content revealed that 91.3% (by volume) consisted of unidentified detritus, 6.9% of plant remains, and 1.0% arthropod remains. Among the plants were diatoms, two of which he attributed to upstream sources, "*Spirogyra* sp., desmids, and epiphytic diatoms" were thought to have originated in weed beds, and *Oscillatoria* sp. in "the local riffle" (p. 135). The small amounts of *Oscillatoria* and *Lyngbya* present in the stomachs suggested to Darnell that the shrimp "were not feeding from the uppermost rocks but remained at the lowermost levels, consuming bits of detritus and other incidental material which filtered through to the bottom of the riffle" (pp. 135, 136). Few insect parts were present, but among the arthropod remains were parts of *Atya scabra*.

In collecting *Potimirim mexicana* (De Saussure, 1857) in the littoral zone of Río Papaloapan, Veracruz, Villalobos (1959:328) found juvenile specimens of *Atya scabra* and members of the genus *Macrobrachium* to be abundant among the submerged roots of the willow (*Salix humboldtiana*), which grows along the banks of the stream. He also reported discovering that *Atya scabra* spends the early stages of its development near the coast, later emigrating up river, becoming dispersed in areas far removed from the river mouths. He stated further that such juvenile forms have general similarity to individuals of *Potimirim mexicana*, and that in order to distinguish between them a certain knowledge of the distinctive features of the two genera is needed.

In their ecological classification of the freshwater decapods of the West Indies, Chace and Hobbs (1969:33) categorized *A. scabra* as a "typically freshwater species that invades marine habitats or have, or probably have, marine larvae." They reported that on Dominica this shrimp had

been found in only a few localities, those at elevations between 17 and 117 meters where it "frequents cascading reaches and riffles of small streams . . . [secreting] itself among the stones over and among which water is rushing. Although it must travel through pools in moving from one congenial niche to another, it was neither observed nor collected in a pool during this study" (p. 66).

Hart and Hart (1969) recorded chemical and physical data collected in two seasons (March and November) from a station in Dominica from which *Atya scabra* was taken; Hunte (1978) provided additional data from two stations in Jamaica. The data from the two localities are summarized in Table 1.

Villamil and Clements (1976:5) believed *A. scabra* "to be the most ecologically restricted and most specialized member of the crustacean fauna of the area [upper Río Espíritu Santo at El Verde, Puerto Rico]. The females were collected only from rocky riffles and the males only from crevices between rocks over which a fast current was flowing."

Fryer (1977) also found *A. scabra* to be comparatively rare on Dominica and limited to habitats similar to those mentioned by Chace and Hobbs. He observed that an adult specimen kept in an aquarium "by day at least . . . had more retiring habits than *A. innocous*, making few appearances from the stones under which it took refuge, save to filter . . ." (p. 72). He found members of the species to feed primarily by filtering the water with the aid of its first and second pereopods. The entrapped "food is transferred and manipulated by the extremely complex oral machinery . . . one of the most elaborate parts of this is a teaselling device in which components of the maxillae and first maxillipeds participate" (p. 58). The feeding mechanism is described by Fryer (pp. 98-104).

Hunte (1978) reported the results of his survey of the freshwater shrimps on the island of Jamaica; in each stream he made collections at high and low altitudes. *Atya scabra* appears to have been found at altitudes in the four localities cited of 335, 152, 380, and 380 meters (the latter two

TABLE 1.—Chemical and physical data for one station on the Pichelin River, Dominica (from Hart and Hart, 1969), and two stations in Jamaica, the Cane and Morant rivers (from Hunte, 1978), from which *Atya scabra* was taken

	Pichelin River		Cane River	Morant River
	Mar 1964	Nov 1966		
pH	7.7	7.6	7.5	7.7
Temperature (°C)	24.0	24.0	22.8	22.3
Dissolved oxygen (ppm)	8.0	7.9	8.5	8.7
Alkalinity (ppm)	42.0	58.6	-	-
CO ₂ (ppm)	1.6	3.7	-	-
Cl (ppm)	13.6	13.6	-	-
Total hardness (ppm)	36.0	36.6	-	-
Calcium hardness (ppm)	22.2	25.0	-	-
Magnesium hardness (ppm)	13.8	11.6	-	-
SO ₄ (ppm)	6.6	6.4	-	-
Ca (ppm)	8.9	10.0	-	-
Mg (ppm)	3.4	2.8	-	-
SiO ₂ (ppm)	-	68.2	-	-
Specific conductivity (micromhos/cm)	-	127.3	-	-
NO ₃ (ppm)	-	-	0.008	0.265
PO ₄ (ppm)	-	-	0.384	0.362

the maximum altitude at which collections were made); however, Hunte (p. 139) stated that this shrimp was found at lower altitudes. Classifying it as a high-gradient species, he also subjected specimens to temperatures of 10°, 15°, 35°, and 40° C and recorded the survival time. They were as follows: 7.7 (±0.07), 31.3 (±2.7), 26 (±7.6), and 4.7 (±2.1) hours, respectively. The temperature of the water in two of the localities where the shrimp was collected was 22.8° and 22.3° C. Three specimens were placed in an unaerated aquarium maintained at 25° C. The time of death ranged from 4.2 to 8.0 hours (mean 5.6 hours) when the oxygen tensions reached a level of a little less than 1.5 to 0.5 mg/l. The oxygen, NO₃, and PO₄ concentrations and pH at two of the localities where the shrimp was found are noted in Table 1, herein. Salinities of the sea near the mouths of the two streams were 31.9‰ and 28.3‰.

There is general agreement among almost all of the observers that *Atya scabra* frequents comparatively shallow (records include no more than one meter), swiftly flowing water where a rocky

substrate exists, although some adult females and juveniles may frequent pools adjacent to riffle areas; young shrimp may also be found among submerged roots of shoreline plants. The altitude at which this shrimp has been collected ranges from sea level to 800 meters.

Should the larval requirements prove to be similar to those of *A. lanipes* and *A. innocous* reported by Hunte (1975, 1979b), then the first molt after hatching must occur in estuarine conditions or at least in brackish water.

LIFE HISTORY DATA AND POPULATION STRUCTURE.—The earliest report of ovigerous females accompanied by date of observation is that of Pearse (1915:551), who observed such females "often during the first week in August" in Santa Marta, Colombia. Villalobos (1943) sampled a population of *A. scabra* inhabiting Río Necaxa at Coyutla, Veracruz, Mexico, during March. His catch included 100 males and 27 females that exhibited a mean carapace length of 28.9 (total length, 68.5) mm and 19.0 (50.0) mm, respectively. In November, he obtained about 400 additional individuals among which there were

about 10% more males than were present in the collection made in March. He measured 100 males that had a mean carapace length of 29.2 (total length, 70.0) mm; some were "individuous gigantes" having a carapace length as great as 38.8 (94.5) mm; smaller adult individuals had corresponding lengths of 23.2 (59.9) mm. Villalobos noted that his collections contained more males than females. Ovigerous individuals were found in both March and November.

In studying a population of *Atya scabra* in the Río Sabinas in southern Tamaulipas, Mexico, Darnell (1956) found the ratio of males to females to be 61:39. He also reported the males to be larger: the average total length was 68.5 mm with a maximum of 94.5 mm, and the average length of the females 50.0 mm. Of 23 females collected in late April, four were ovigerous; their total length and number of eggs (in parentheses) carried were as follows: 57.5 mm (8000 estimated), 50.5 mm (1111), 47.5 mm (1865), and 43.0 mm (746). The smallest female with ovarian eggs "large enough to be considered mature" had a total length of 39.0 mm. Two females of comparable size had "what appeared to be recently spent ovaries" (p. 137). Basing his opinion on the varied stages of development of the ovarian eggs, he expressed the belief, formerly stated by Villalobos, that "breeding takes place during most of the year" (p. 137). The average length of the eggs was 0.84 mm. Ovarian eggs of 13 nonovigerous females collected at that time had average lengths ranging from 0.38 to 0.87 mm. He suggested that a logarithmic relationship exists between body size and number of undeveloped eggs carried on the abdomen of the female. Assuming this to be factual, he calculated that the female with a total length of 50.5 mm should have carried about 3000 eggs instead of 1111 and concluded that "about 60 percent mortality is indicated for a group of eggs which had reached the eye pigment stage" (p. 137).

The dimensions of the eggs carried by specimens from the Cape Verde Islands and Venezuela were reported by Bouvier (1925:316) to be 0.58–0.64 × 0.40 and 0.65 × 0.37 mm, respectively.

Chace and Hobbs (1969:66) reported collections on Dominica of 15 males and four females of which one among the latter, collected on 29 January, was ovigerous. Lévêque (1974) observed ovigerous females on Guadeloupe in June. Bonnelly de Calventi (1974b:40) reported the occurrence of ovigerous females in March, April, May, June, July, September, October, and November.

The only information on longevity is that of Fryer (1977:72), who reported maintaining an adult individual in an aquarium with several specimens of *A. innocous* for 2.5 years.

Summarizing the data presented here, ovigerous females have been found in African waters in March, May, July, and August and in American waters in every month of the year. The smallest and largest ovigerous females that we have examined have carapace lengths of 7.1 and 29.5 mm, respectively.

COMMON NAMES.—The following common names have been applied to *Atya scabra*.

- Bomingomô (in Batanga), Cameroon (Monod, 1928:206)
- Bouc on Martinique (Pinchon, 1967:161)
- Cacador in Guadeloupe (Holthuis, 1980:70) and in Dominica; also applied to *A. innocous* in Guadeloupe (Lévêque, 1974:42) and in Dominica
- Camacuto in Venezuela (Davant, 1963:42)
- Camarão on São Tomé (Osorio, 1889:139)
- Chacales (probably derived from the Nautl word "chacalli," according to Villalobos) in Veracruz, Mexico (Villalobos, 1943:12)
- Conca, Cruca, or Camarão de pedra in northern Brazil (Fausto Filho, 1968:28)
- Coruca in Pernambuco, Brazil (Holthuis, 1980:70)
- Crevette gros-doigt in Cameroon (Monod, 1928:458)
- Dikuta (in Bassa Bania), Cameroon (Monod, 1928:206)
- Èkusa (in Soubou), Cameroon (Monod, 1928:206)
- Guábaras on Cuba (Gundlach, 1887:131)
- Guaricuru in Brazil (Marcgrave, 1648:187)
- Inzé on Annobón (Osorio, 1895a:249)
- Janga or Jonga on Jamaica; apparently applied to any freshwater shrimp on the island (Hart, 1961a:3)
- Langostino in Dominican Republic (also applied to *A. innocous*; Bonnelly de Calventi, 1974b:40)
- Langosta in Dominican Republic (also applied to *A. innocous* and *A. lanipes*; Bonnelly de Calventi, 1974b:40)
- Mobéngomô (in Douala), Cameroon (Monod, 1928:205)
- Patia in Dominican Republic (Bonnelly de Calventi, 1974b:40)
- Pepeluña in Dominican Republic (Bonnelly de Calventi, 1974b:40)

Sutu-feelee or "Bitter crayfish" in Africa (Rathbun, 1900:313)

Vieja in Dominican Republic (Bonnely de Calventi, 1974b:40)

Viejitas in Cuba (also applied to *Atya innocous*) (Alayo, 1974:22)

Zapata in Dominican Republic (Bonnely de Calventi, 1974b:40)

According to Holthuis (1980), the FAO names for the American *Atya scabra* are: Camacuto shrimp (English), Saltarelle camacuto (French), Camerón camacuto (Spanish). For the African representatives (formerly assigned to *Atya sulcatispes*), the FAO names are: Ekusa shrimp (English), Saltarelle ekusa (French), and Camerón ecusa (Spanish).

ECONOMIC IMPORTANCE.—Guilding (1825:338)

stated that *Atya scabra* were caught for the market on Saint Vincent, and Gundlach (1887:131) reported their being in the market in San Juan, Puerto Rico. They were mentioned as being "excellent for eating" by Johnston (1906:843) in treating the fauna of Liberia. In their list of the shrimps and prawns of economic importance, Holthuis and Rosa (1965:9) reported that they were fished in the following: Mexico, Costa Rica, Panama, Nicaragua, British Caribbean Federation, Cuba, Haiti, Puerto Rico, Netherlands West Indies, and Venezuela. (Their Peruvian citation is for *Atya margaritacea*.) Chace and Hobbs (1969:45) also noted that they were eaten on Dominica. One of us (CWH) was informed that this shrimp is a food item on Jamaica.

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