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**Abstract**: A new genus and species of stygobiontic bidessine dytiscid beetle, *Comaldessus stygius*, from Comal Springs, Texas, is described and compared with the proposed sister epigean genus *Uvarus* and the only other known stygobiontic bidessine water beetles, *Trogloguignotus concii* Sanfilippo from Venezuela and *Uvarus chappuisi* (Peschet) from Africa. Distinctive characters of the adult are illustrated with pen and ink drawings and scanning electron micrographs. The new taxon is the second stygobiontic bidessine genus with rudimentary eyes known from the Western Hemisphere and the first known from North America.

## Introduction

The new taxon described in the following account was first collected during a survey by the junior author to examine the distribution of a recently described stygobiontic dryopid beetle, *Stygoparnus comalensis* Barr and Spangler (1992). The survey was conducted for the U.S. Fish and Wildlife Service in 1992 and involved several springs of the Edwards Aquifer (Balcones Fault Zone). Among the springs examined were Comal Springs at New Braunfels, Texas, the type locality of *S. comalensis* and this previously unknown dytiscid. Additional specimens of *Comaldessus stygius*, new genus, new species, were collected in 1993 during the Habitat and Flow Requirements Study for the Comal Ecosystem by the U.S. Fish and Wildlife Service.

Comal Springs emerge along the base of the Balcones Escarpment and are fed by the Edwards Aquifer (Balcones Fault Zone) of south-central Texas. The aquifer extends for 282 km in a crescent from Bracketville in Kinney County to Kyle in Hays County, and ranges from 8 to 48 km in width. Water enters the aquifer in the recharge zone where streams cross exposed, porous limestone. The underground water is subjected to increasing hydrostatic pressure as it flows towards the east and northeast. In the artesian zone, faulting of the water-bearing limestone against impermeable layers causes the water to be forced to the surface as artesian springs. According to Holsinger and Longley (1980), this karst area has been subjected to intense faulting and fracturing, which probably has resulted in the development of many phreatic reservoirs. The reservoirs, in turn, probably led to the isolation of aquatic populations and the extensive speciation (43 species and subspecies) reported from the artesian zone of the aquifer by Bowles and Arsuffi (1993). For additional details of the fauna and geology of the Edwards Aquifer see Barr and Spangler (1992), Bowles and Arsuffi (1993), Brune (1981), Holsinger and Longley (1980), Klemt *et al.* (1979), Longley (1981, 1986), Ogden *et al.* (1986), Pearson *et al.* (1975), and Rothermel and Ogden (1987).

## Collecting Methods

Using drift nets at four sites, Barr sampled spring water discharge over a continuous period of about 100 hours. Drift nets used at outlets with large volumes were 0.30 m X 0.45 m, had a mesh size of 363 microns, and had a plexiglass collection bottle. Barr used standard aerial and aquatic insect net bags as improvised drift nets at springs with low flow. Material trapped in the nets was preserved in alcohol in half-pint jars for later examination. Similar drift collection techniques were employed by R. Stanford of the U.S. Fish and Wildlife Service, who used plankton tow nets with a diameter of 200 mm., mesh of 118 microns, and set for approximately 24 hours.

## Systematics

Using Young's (1967) key to the American bidessine genera, the new genus keys to *Uvarus* and the monotypic Venezuelan genus *Trogloguignotus* Sanfilippo (1958) at couplet 12; and then, because both *T. concii* and *Comaldessus stygius*, new species, have rudimentary eyes, to *Trogloguignotus concii* Sanfilippo (1958). Because of the two-segmented parameres and rudimentary eyes, *Comaldessus* keys to the African *Uvarus chappuisi* (Peschet, 1932) and *Trogloguignotus concii* in couplet 5 of the key in Biström's (1988) review of the bidessine genera of the world.

Although both *Comaldessus* and *Trogloguignotus* appear to be derived from the primarily pantropical and speciose genus *Uvarus* (50 species), they are more similar morphologically to each other than to *Uvarus*. The similarity to each other may be an expression of convergence in response to their subterranean habitats.

We have not seen specimens of the African *Uvarus chappuisi* nor the Venezuelan *Trogloguignotus concii* but have reviewed Guignot's (1959:312) description of *U. chappuisi* based on his examination of Peschet's unique male type in the National Museum of Natural History in Paris. We also have consulted Biström's (1988:16) description of *T. concii* based on his examination of two paratypes of that taxon in the Sanfilippo collection and the Genova Museum. Both Biström's and Guignot's detailed characterizations included the description of metacoxal lines that are present on both *T. concii* and *U. chappuisi*.

The coxal lines are not present on *Comaldessus* and this unique character alone will distinguish *Comaldessus* from the 30 other described bidessine genera.

### *Comaldessus*, new genus

**Diagnosis:** A very small (length, 1.50 mm. & width, 0.71 mm.), subparallel-sided, stygobiontic dytiscid with the characteristics of the subfamily Hydroporinae and the tribe Bidessini. The absence of metacoxal lines will separate this genus from all other bidessine genera presently described.

**Adult**: Very small (length, 1.50 mm. & width, 0.71 mm.). Body subparallel-sided (Figures 1, 8, 9). Color pale reddish brown. Head without cervical stria and frontal area not swollen nor rimmed. Eyes rudimentary, with only indications of a few ommatidia (Figures 10, 11, 12). Palpi short, robust, not bifid apically. Pronotum with basal plicae extending almost ½ length of pronotum (Figure 13). Elytra with basal plicae; plicae about a third longer than pronotal plicae; without sutural striae; without carinae; apices angled toward midline. Epipleuron without oblique subbasal carina. Metathoracic wings absent. Prosternum anterior to procoxae about 2/3 length of procoxa (Figure 14). Prosternal process reaches metasternum, very narrow between procoxae then widening behind procoxae and narrowing to apex (Figures 7 & 15). Metasternum not carinate laterally and not depressed behind mesocoxae; coarsely punctate, punctures randomly scattered. Metacoxal lines absent (Figure 16). Legs slender.

Abdomen with 6 visible sterna but visible sterna 2 and 3 fused.

Genitalia as illustrated (Figures 5 & 6). Median lobe broad basally, converging but moderately broad at apex. Paramere, 2 segmented.

**Etymology:** The masculine generic name is a combination of *Comal,* in reference to Comal Springs, Texas, the type locality, and *dessus,* the suffix of the type genus of the tribe, *Bidessus*.

**Type species of the genus**: *Comaldessus stygius*, new species.

### *Comaldessus stygius*, new species
Figures 1-22

**Diagnosis:** *Comaldessus stygius* differs from all known North American bidessine species by the following combination of characters: rudimentary eyes (Figures 1 & 11); absence of metathoracic wings; absence of metacoxal lines (Figure 16); pale reddish-brown, thin, nearly transparent integument; and pronotum, elytra, and legs with numerous, well-developed, fine, sensory setae.

**Holotype, m**: Body form and size (figures 1 and 8): Elongate, subparallel sided, somewhat flattened.

Pronotum sinuate laterally; narrowed anteriorly and posteriorly. Total length, 1.50 mm.; length of elytron, 1.0 mm.; greatest width, near midlength of elytra, 0.71 mm.. Length of pronotum on midline, 0.28 mm.; greatest width of pronotum, at about apical third, 0.63 mm.; width of pronotum at apex, 0.50 mm.; width of pronotum at base, 0.57 mm..

**Head:** Broad, almost as wide as pronotum at apex; rounded anteriorly; subparallel laterally and slightly converging posteriorly. Eyes rudimentary (Figures 10, 11, 12); only indications of ommatidia; shallowly concave medially and margins slightly raised at level of anterolateral angles of pronotum where posterolateral edge of normal compound eye would be found if present. Cuticular surface finely, shallowly microreticulate and finely, very sparsely punctate; punctures on vertex separated by 4-10 times puncture diameter (Figures 10 & 11). Labial palpus, 3 segmented (Figure 3). Maxillary palpus, 4 segmented (Figure 4).

**Thorax:** Pronotal surface microreticulate and more densely punctate than head; meshes and punctures slightly larger than those on head (Figure 10). Pronotum with anterior, submarginal, ill-defined, transverse row of punctures; each puncture with a slender, yellow, hair-like seta; with basolateral, distinct, longitudinal plica extending from hind margin almost to midlength (Figure 13). Lateral margins of pronotum narrowly rimmed (Figure 13) and constricted in basal half so junction between pronotum and base of elytra is discontinuous. Elytra elongate, finely rimmed laterally, not fused; narrowed basally at junction with base of pronotum then widening so that medial third of lateral margins are almost parallel; apical margins curve in to apices. Elytra with distinct basal plicae; plicae incurved and slightly longer than pronotal plicae (Figure 13). Elytral cuticular surface microreticulate and punctate similarly to pronotum; punctures with yellow, hair-like setae; setae along lateral margins much longer. Sutural striae absent but indicated by rows of darkened spots. Hind wings absent. Epipleuron shallowly concave; coarsely, sparsely punctate and microreticulate; broad at base then narrowing until disappearing at about level of fourth visible abdominal sternum. Prosternum, mesosternum, and metasternum finely, densely punctate. Prosternal process extends to metasternum; very narrow between procoxae, widening behind procoxae, and narrowing to apex (Figure 15). Metasternal wing-like processes short and narrow; discrimen distinctly grooved. Metacoxal processes with apicolateral, shallow emargination (Figure 16). Profemur (Figures 18 & 20), mesofemur, and metafemur with few small punctures on upper (anterior) surface. Profemur with short, shallow, subapical, arcuate emargination on ventral margin; emargination with fringe of short, dense, golden setae (Figure 20). Protibia, mesotibia, and metatibia each with lateral fringe of long natatory setae (Figure 1). Metatibia slender to expanded apex (Figure 21). Protarsus and mesotarsus pseudotetramerous; segment 4 tiny and obscured between lobes of segment 3 and segment 5 (Figures 14, 17, 18). Adhesive disks dense on tarsal segments 1 and 2 (Figures 18 & 19). Metatarsus distinctly 5 segmented; segments 1-3 each with fringe of long natatory setae on medial (inner) margin (Figure 22). All tarsal claws long, slender, and equal in length (Figure 17).

**Abdomen:** Integument finely microreticulate and punctate; microreticulation becoming effaced on last three visible sterna; punctures coarse and sparse, each puncture with slender, yellow, hair-like seta. Sternum 4 with a coarse puncture bearing a long, stout, medial seta. Sternum 5 with a similar medial puncture and seta plus a smaller puncture and a shorter, stout seta on each side of medial seta.

**Genitalia:** As illustrated (Figures 5 & 6).

**Female**: Externally, similar to male except tarsal segments 1-3 not broadened, without adhesive pads.

**Variations**: The only variation noticed among the 12 specimens seen was in the shape of the prosternal process. A single specimen had the prosternal process considerably narrower than that illustrated for the holotype (Figure 7). The narrower process may have been caused by shrinkage of the soft, thin exoskeleton of these stygobiontic beetles after they were removed from alcohol.

**Type Data**: *Holotype:* USA: TEXAS: Comal County, New Braunfels, Landa Park, Comal Spring 3, net near springhead, 10-14 Aug 1992, C.B. Barr; deposited in the National Museum of Natural History, Smithsonian Institution.

**Allotype:** Same data as holotype.

**Paratypes:** Same data as holotype, 4♂, 1♀ (1♂ deposited in the California Academy of Sciences, San Francisco, California & 1 ♂ deposited in the private collection of Cheryl B. Barr); same data as holotype except Comal Spring 1, cave outlet, 2♂, 1♀ (1♂ deposited in the collections of the Texas Agricultural and Mechanical University, College Station, Texas; same data as holotype except Comal Spring 4, springhead, drift net A, 29-30 July 1993, R. Stanford, 1♀; same data as holotype except Comal Spring 3, springhead, drift net B, 2-3 Nov 1993, R. Stanford, 1♀.

**Etymology**: The specific name *stygius* is derived from the Greek Styx, a river in the netherworld.

**Habitat:** All of the known specimens of *C. stygius* were collected from the Comal Springs complex located in New Braunfels, Texas, in city-owned Landa Park and adjacent city-owned property. The four main spring groups (Comal 1-4) at an elevation of ca 190 m emerge from Edwards and associated limestones at the Comal Springs fault.

The water of Comal Springs is derived from a deep flow, phreatic conduit system. The principal recharge area lies about 100 km to the west (Brune, 1981) and the water migrates to depths more than 610 m below the surface before emerging at the springs (Ogden *et al.*, 1986). As a consequence of the deep circulation, the water is never turbid and is free from bacterial contamination when it emerges from the spring openings. According to Pearson et al. (1975), most of the water has been in the aquifer system for more than 20 years and only a small portion is less than 10 years old. The mean historic flow, which is steadily decreasing, has been approximately 300 cfs (8496 lps) (Ogden *et al.*, 1986); however, during the survey by Barr, 7-21 August 1992, the spring flow was above average and ranged from 458 cfs (12,971 lps) to 468 cfs (13,254 lps). The spring flow was also above average during the surveys by Stanford: 29-30 July 1993, 397 cfs (11,243 lps); 2-3 November 1993, 348.5 cfs (9870 lps).

**Comal Spring 1 :** Three specimens of *C. stygius* were collected from Comal Spring 1, which is located at the northwest corner of Landa Park and has the second largest discharge of the four major spring groups (Ogden *et al.*, 1985a, 1985b). Comal Spring 1 is at the highest elevation and is the first to stop flowing when the total discharge of the springs falls to about 100 cfs (2832 lps) (Whatley, personal communications, 1993). The main orifice is a shallow limestone cave about 0.6 m in diameter. At the time the specimens were collected the water depth was 0.15 m and the flow from the main orifice and two adjacent outlets formed a short, swift (3.2-4.4 f/s) run that emptied into the main spring run. The substrate in the various orifices was bedrock, cobble, gravel, and (to a lesser extent) sand. The three specimens of *C. stygius* were collected in a drift net installed at the cave mouth and operated for 100 hours.

**Comal Spring 3 :** Eight specimens of *C. stygius* were collected from this spring located about 152 m northeast of Comal 2 along the base of the fault escarpment. Based on the amount of discharge, this spring is the largest of the four spring groups (Ogden *et al.* 1985a, 1985b). There are many orifices at the head of the run and along the escarpment almost to Landa Lake. The orifices and run have a substrate of gravel, cobble, boulders and bedrock. Seven specimens were collected in a drift net set by Barr and operated for 100.5 hours at the orifice with the largest discharge, which is located beneath the escarpment bank and near the head of the run. The opening, 1 m in diameter, was on the bottom, under water at a depth of 0.65 m; water velocity was 1.8 f/s. An additional specimen was taken by Stanford in a drift net set for 22.5 hours at the head of the run just upstream from the orifice described above.

**Comal Spring 4 :** One specimen of *C. stygius* was collected from this spring run located at the end of the northeast arm of Landa Lake. The site is adjacent to and owned by the New Braunfels Utility and is near the municipal water wells. At the head of the channel there are two main outlets that emerge at the base of a cement wall which is 3.7 m wide. Both outlets had rather low discharge. The specimen was collected in a drift net set for 26-27 hours at the left orifice by R. Stanford.

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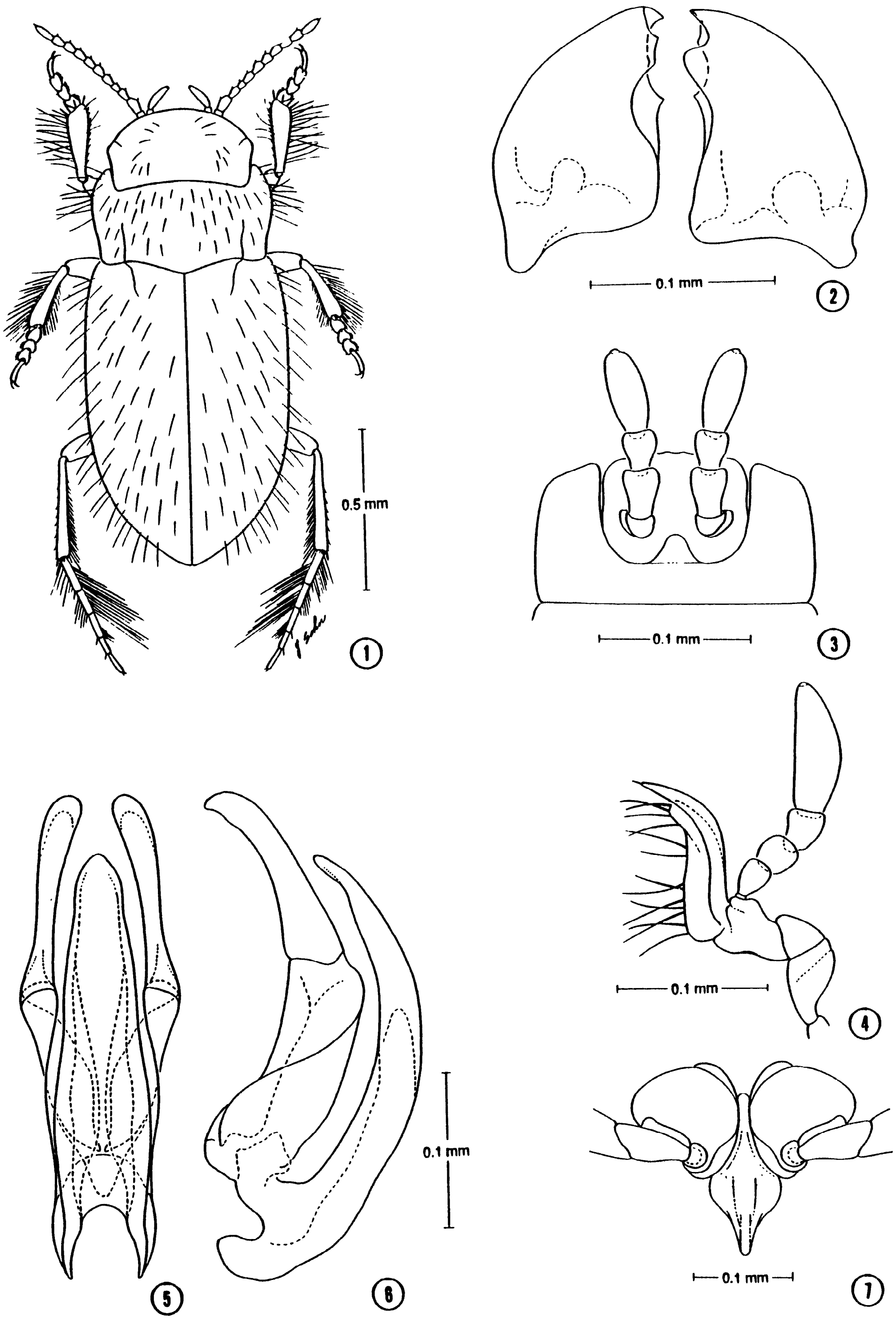
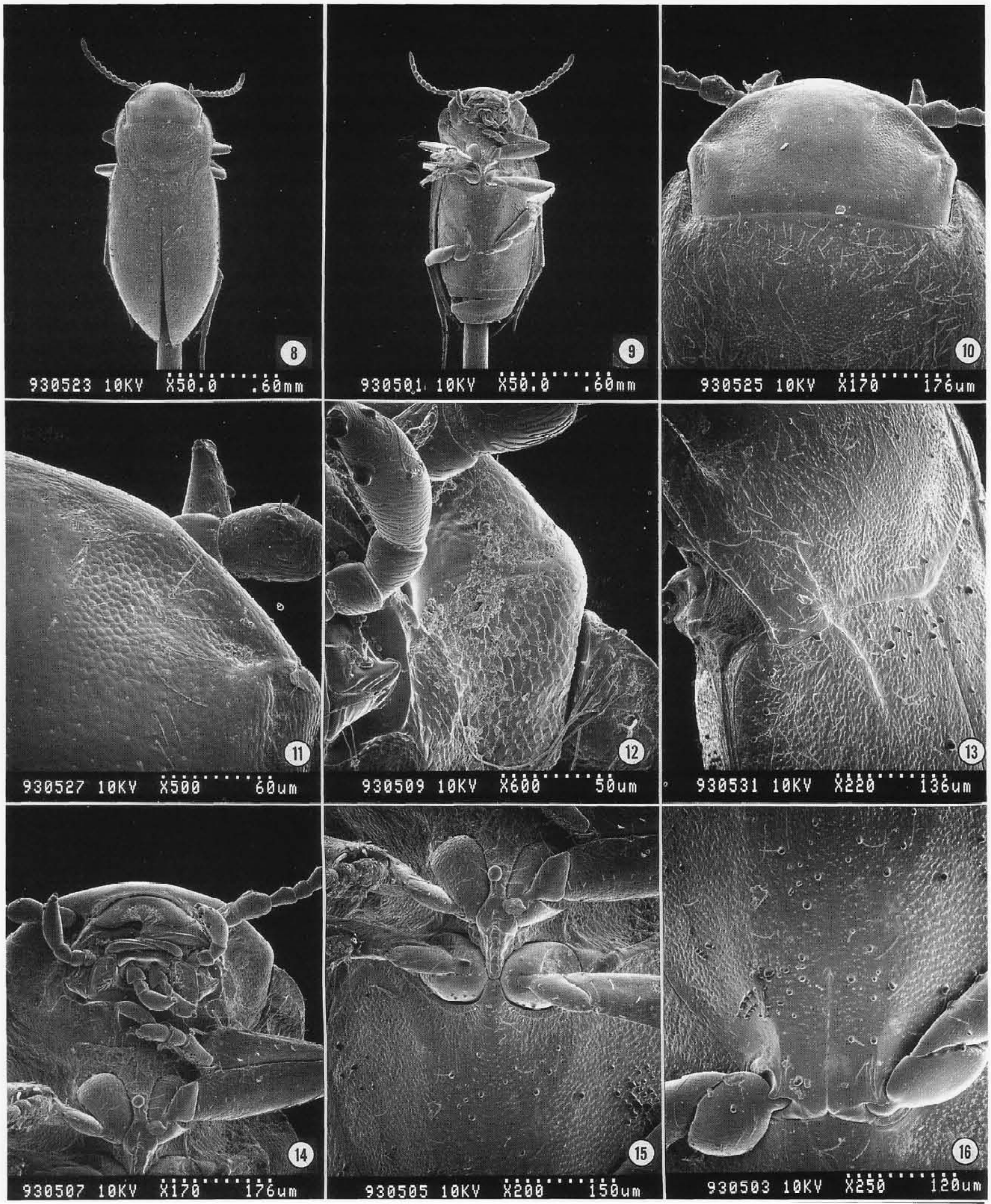
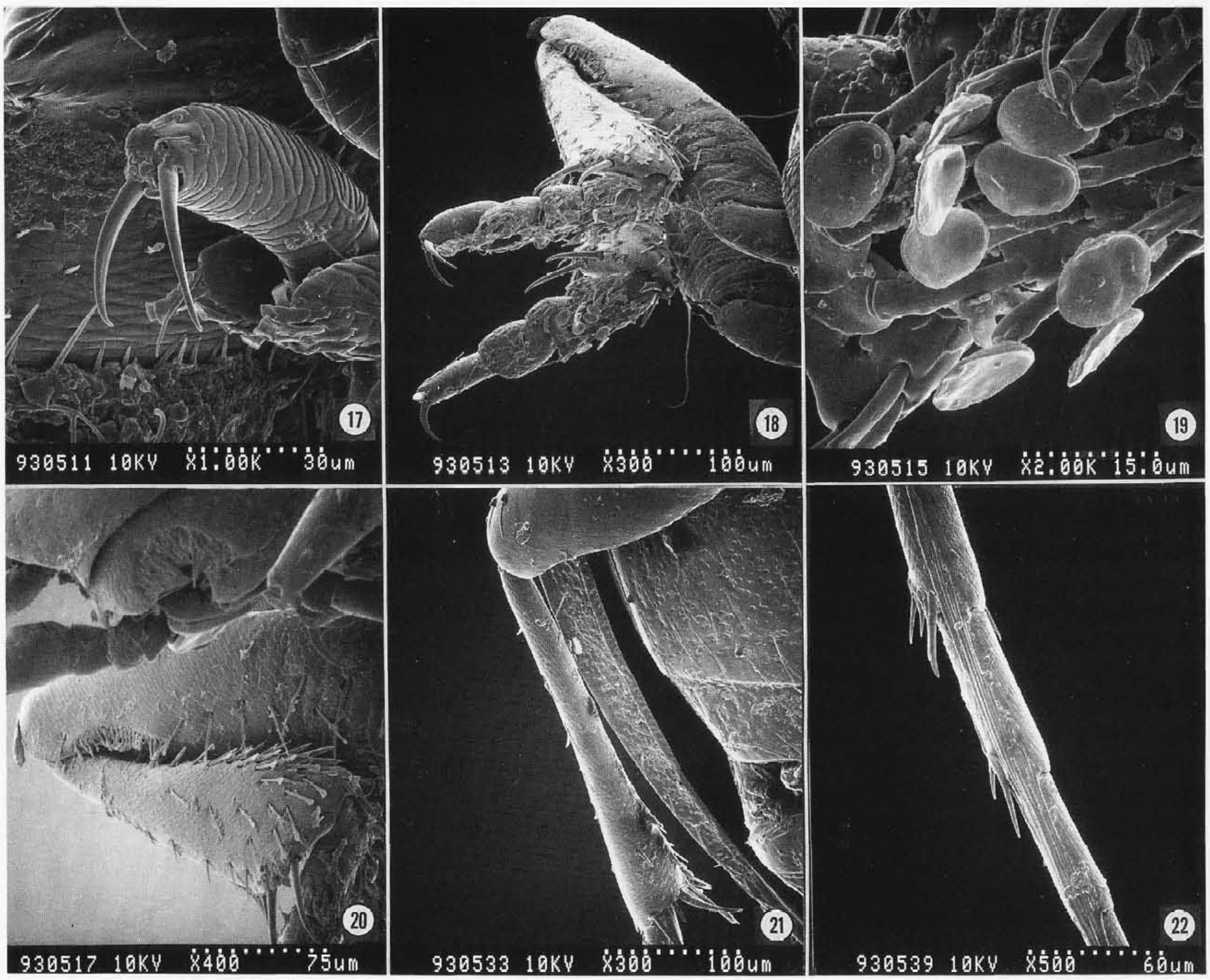



**Figures 1-7**: *Comaldessus stygius*, new species, male: 1, habitus, dorsal view; 2, mandibles; 3, labium and labial palpi; 4, maxilla and maxillary palpus; 5, male genitalia, dorsal view; 6, male genitalia, median lobe and 1 paramere, lateral view; 7, prosternal process.




**Figures 8-16**: *Comaldessus stygius*, new species, male: 8, habitus, dorsal view, X50; 9, habitus, ventral view, X50; 10, head, rudimentary eyes, and pronotum, dorsal view, X170; 11, ocular area, dorsal view, X500; 12, ocular area, ventral view, X600; 13, plicae, pronotal and elytral, oblique view, X220; 14, head, prosternum, and mouthparts, ventral view, X170; 15, prosternum, mesosternum, and metasternum, X200; 16, metacoxal plates, metacoxal processes, and discrimen, X250.




**Figures 17-22**. *Comaldessus stygius*, new species, male: 17, protarsal claws, X1000; 18, front and middle legs, X300; 19, mesotarsal adhesive disks, X2000; 20, labrum and foreleg, X400; 21, metatibia, ventral surface, X300; 22, metatarsus, hair-like natatory setae, inner margin, X500.