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**New species (130) of the hyperdiverse aquatic beetle genus  
*Hydraena* Kugelann from Papua New Guinea, and a preliminary  
analysis of areas of endemism (Coleoptera: Hydraenidae)**

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## Abstract

The Papua New Guinea (PNG) species of the water beetle genus *Hydraena* Kugelann, 1794, are revised, based on the study of 7,411 databased specimens. The two previously named species are redescribed, and 130 new species are described. The species are placed in 32 species groups. High resolution digital images of all primary types are presented (online version in color), scanning electron micrographs of representative species are given, and geographic distributions are mapped. Male genitalia, representative female terminal abdominal segments and representative spermathecae are illustrated. Papua New Guinea *Hydraena* species are typically found in sandy/gravelly stream margins, often in association with streamside litter; some species are primarily pond or swamp dwelling, and a few species are usually found in the hypopetric splash zone on stream boulders or on rocks at the margins of waterfalls. The geographic distributions of PNG *Hydraena* are compared with the Areas of Freshwater Endemism recently proposed by Polhemus and Allen (2007), and found to substantially support those areas. Only one species, *H. impercepta* Zwick, 1977 is known to be found in both Australia and Papua New Guinea. The probable Australian origins of the PNG hydraenid genera *Gymnochthebius* and *Limnebius* are discussed. The origins of just a few species of PNG *Hydraena* appear to clearly be Australia, and of comparatively recent origin, whereas the origins of the remainder remain problematic because of lack of knowledge of the *Hydraena* fauna in Papua Province, Indonesia, and islands large and small to the west of New Guinea. No endemic genera of Hydraenidae are currently known for New Guinea, whereas 98% of the known species are endemic. New species of *Hydraena* are: *H. acumena* (Eastern Highlands Province: Koma River, tributary of Fio River), *H. adelbertensis* (Madang Province: Adelbert Mts., below Keki), *H. akameku* (Madang Province: Akameku–Brahmin, Bismarck Range), *H. alta-papua* (Southern Highlands Province: Sopulkul, 30–35 km NE Mendi), *H. ambra* (Eastern Highlands Province: Wanitabi Valley, nr. Okapa), *H. ambripes* (Madang Province: Finisterre Mts., Naho River Valley, Budemu), *H. ambroides* (Eastern Highlands Province: Wanitabi Valley, nr. Okapa), *H. apertista* (Madang Province: Finisterre Mts., Lower Naho Valley, Hinggia), *H. apexa* (Eastern Highlands Province: Okapa), *H. aquila* (Madang Province: Simbai area), *H. aulaarta* (Western Highlands Province: Kundum), *H. austrobesa* (Central Province: nr. Port Moresby, Sogeri Plateau, Musgrave River), *H. bacchusi* (Eastern Highlands Province: Wanitabi Valley, nr. Okapa), *H. balkei* (Eastern Highlands Province: Akameku–Brahmin, Bismarck Range), *H. bicarinova* (Eastern Highlands Province: Wanitabi Valley, nr. Okapa), *H. bifunda* (Morobe Province: c. 7 mi. Lae–Bulolo road), *H. biundulata* (Morobe Province: Lae–Bulolo road), *H. brahman* (Madang Province: Ramu Valley, 4.5 km N Brahman), *H. bubulla* (Madang Province: Akameku–Brahmin, Bismarck Range), *H. buloba* (Morobe Province: Herzog Mts., Wagau), *H. buquintana* (Western Highlands Province: Mt. Hagen town area), *H. carinocisiva* (Eastern Highlands Province: Aiyura), *H. carmellita* (Morobe Province: Herzog Mts., Wagau), *H. cavi-frons* (Madang Province: Ramu Valley, 4.5 km N Brahman), *H. cheesmanae* (Central Province: Kokoda), *H. clarinis* (Madang Province: Sepik Ramu Basin, Kojé Creek), *H. colorata* (Morobe Province: 5 miles W of Lae, Buins Creek), *H. confluenta* (Eastern Highlands Province: Umg. [=environs of] Kainantu, Onerunka), *H. copulata* (Gulf Province: Marawaka, Mala), *H. cunicula* (Madang Province: Akameku–Brahmin, Bismarck Range), *H. decepta* (Eastern Highlands Province: Okapa), *H. diadema* (Eastern Highlands Province: Purosa Valley, nr. Okapa), *H. dudgeoni* (Madang Province: Sepik Ramu Basin, Kojé Creek), *H. einsteini* (Central Province: Port Moresby–Brown River road), *H. essentia* (Eastern Highlands Province: Sepik River Basin, stream beside milestone labelled G-99), *H. exhalista* (Gulf Province: Marawaka, Mala), *H. fasciata* (Morobe Province: Herzog Mts., Wagau), *H. fascinata* (Madang Province: Finisterre Mts., Naho River Valley, nr. Moro), *H. fasciolata* (Madang Province: Madang, Ohu Village), *H. fasciopaca* (Madang Province: Keki, Adelbert Mts.), *H. fenestella* (Morobe Province: Lae–Bulolo road), *H. foliobba* (Morobe Province: Herzog Mts., Wagau), *H. formosopala* (East Sepik Province: Prince Alexander Mts., Wewak), *H. funda* (Central Province: Moitaka, 7 miles N of Port Moresby), *H. fundacta* (Madang Province: Adelbert Mts., Sewan–Keki), *H. fundapta* (Central Province: Port Moresby–Brown River road), *H. fundarca* (Eastern Highlands Province: Okapa), *H. fundextra* (Morobe Province: Markham Valley, Gusap), *H. galea* (Eastern Highlands Province: Akameku–Brahmin, Bismarck Range, 700 m), *H. herzogestella* (Morobe Province: Herzog Mts., Bundun), *H. hornabrooki* (East Sepik Province: Sepik, main river), *H. huonica* (Madang Province: Kewensa, Finisterre Range, Yupna, Huon Peninsula), *H. ibalimi* (Sandaun Province: Mianmin), *H. idema* (Eastern Highlands Province: Umg. [=environs of] Onerunka, Ramu River), *H. impala* (Central Province: nr. Port Moresby, Sogeri Plateau, Musgrave River), *H. incisiva* (Morobe Province: Herzog Mts., Wagau), *H. incista* (Western Highlands Province: Simbai, Kairong River), *H. infoveola* (Gulf Province: Marawaka, Mala), *H. inhalista* (Madang Province: Finisterre Mts., Naho River Valley, Damanti), *H. inplacopaca* (Eastern Highlands Province: Waisa, nr. Okapa), *H. insandalia* (Eastern Highlands Province: Headwaters of Fio River, 0.5 km downstream of river crossing on Herowana/Oke Lookout path, ca. 4.5 km N of Herowana airstrip), *H. intensa* (Morobe Province: Lae–Bulolo road), *H. johncoltranei* (National Capital District, Varirata NP), *H. jubilata* (Madang Province: Finisterre Mts., Naho River Valley, Budemu), *H. koje* (Madang Province: Sepik Ramu Basin, Kojé Creek), *H. koma* (Eastern Highlands Province: Koma River, tributary of Fio River, 100 m downstream of rattan bridge crossing, ca. 3.8 km S by E of Herowana airstrip), *H. labropaca* (Central Province: nr. Port Moresby, Sogeri Plateau, Musgrave River), *H. lassulipes* (Morobe Province: Herzog Mts., Wagau), *H. limbobesa* (Gulf Province: Marawaka, near Ande), *H. maculopala* (Madang Province: Madang, Ohu Village), *H. manulea* (Morobe Province: Lae, Buins Creek), *H. manuloides* (Central Province: Port Moresby–Brown River road), *H. marawaka* (Gulf Province: Marawaka, Mala), *H. mercuriala* (Sandaun Province: May River), *H. mianminica* (Sandaun Province:

May River), *H. nanocolorata* (Madang Province: Sepik Ramu Basin, Kojé Creek), *H. nanopala* (Madang Province: Sepik Ramu Basin, Kojé Creek), *H. nitidimenta* (Eastern Highlands Province: Koma River, tributary of Fio River, at rattan bridge crossing, ca. 2.6 km N by W of Herowana airstrip), *H. okapa* (Eastern Highlands Province: Wanitabi Valley, nr. Okapa), *H. ollopa* (Western Highlands Province: Kundum), *H. otiarca* (Morobe Province: Herzog Mts., Wagau, Snake River), *H. owenobesa* (Morobe Province: ca. 10 km S Garaina Saureri), *H. pacificica* (Morobe Province: Huon Pen., Kwapsanek), *H. pala* (Morobe Province: Lae–Bulolo road, Gurakor Creek), *H. palamita* (Central Province: nr. Port Moresby, Sogeri Plateau, Musgrave River), *H. paxillipes* (Morobe Province: Lae–Bulolo road, Patep Creek), *H. pectenata* (Madang Province: Finisterre Mts., Naho River Valley, Damanti), *H. pegopyga* (Madang Province: Ramu Valley, 3 km N Brahman), *H. penultimata* (Sandaun Province: May River), *H. perpunctata* (Madang Province: Sepik Ramu Basin, Kojé Creek), *H. pertransversa* (Eastern Highlands Province: Clear stream, summit of Kassem Pass at forest level), *H. phainops* (Morobe Province: Lae–Bulolo road, Patep Creek), *H. photogenica* (Eastern Highlands Province: Goroka, Mt. Gahavisuka), *H. picula* (Eastern Highlands Province: Goroka, Daulo Pass), *H. pilulambra* (Eastern Highlands Province: Clear stream, summit of Kassem Pass at forest level), *H. pluralitcola* (Morobe Province: c. 7 miles Lae–Bulolo road), *H. processa* (Morobe Province: Herzog Mts., Wagau), *H. quadriplumipes* (Madang Province: Aiome area), *H. quintana* (Morobe Province: Markham Valley, Lae–Kainantu road, Erap R), *H. ramuensis* (Madang Province: Ramu Valley, 6 km N Brahman), *H. ramuquintana* (Madang Province: Ramu Valley, 6 km N Brahman), *H. receptiva* (Morobe Province: Lae–Bulolo road), *H. remulipes* (Morobe Province: Herzog Mts., Wagau), *H. reticulobesa* (Madang Province: Finisterre Mts., Naho River Valley, Moro), *H. sagatai* (Sandaun Province: Abau River), *H. saluta* (Madang Province: Finisterre Mts., Naho River Valley, Damanti), *H. sepikramuensis* (Madang Province: Ramu Valley, Sare River, 4 km N Brahman), *H. sexarcuata* (Eastern Highlands Province: Akameku–Brahmin, Bismarck Range), *H. sexsuprema* (Madang Province: Finisterre Mts., Naho River Valley, Damanti), *H. spinobesa* (Madang Province: Finisterre Mts., Naho River Valley, Budemu), *H. striolata* (Oro Province: Northern District, Tanbugal Afore village), *H. supersexa* (Eastern Highlands Province: Okapa), *H. supina* (Eastern Highlands Province: Wanitabi Valley, nr. Okapa), *H. tarsotricha* (Morobe Province: Herzog Mts., Wagau, Snake River), *H. tetana* (Eastern Highlands Province: Okapa), *H. thola* (Central Province: Port Moresby–Brown River road), *H. tholatoris* (Morobe Province: Markham Valley, Gusap, c. 90 miles NW of Lae), *H. thumbelina* (Madang Province: Finisterre Mts., Naho River Valley, Damanti), *H. thumbelipes* (Sandaun Province: Mianmin), *H. tibiopaca* (Morobe Province: ridge between Aseki–Menyamy), *H. torosopala* (Madang Province: Keki, Adelbert Mts.), *H. torricellica* (Morobe Province: Torricelli Mts., village below Sibilanga Stn.), *H. transvallis* (Madang Province: Finisterre Mts., Naho River Valley, Damanti), *H. trichotarsa* (Morobe Province: Lae–Bulolo road), *H. tricosipes* (Morobe Province: Herzog Mts., Wagau), *H. tritropis* (Madang Province: Sepik Ramu Basin, Kojé Creek), *H. tritutela* (Morobe Province: ca. 10 km S Garaina Saureri), *H. ulna* (Morobe Province: Herzog Mts., Wagau), *H. variopaca* (Eastern Highlands Province: Wanitabi Valley, nr. Okapa), *H. velvetina* (Eastern Highlands Province: Purosa Valley, nr. Okapa).

**Key words:** Coleoptera, Hydraenidae, *Hydraena*, new species, Papua New Guinea, aquatic insects, aquatic microhabitats, areas of endemism, holotype digital images

## Introduction

The island of New Guinea has one of the most complex geological histories in the world (Pigram & Davies 1987, Polhemus 2007), and is one of the most diverse lands in topography, climate, and microclimates. Being near the equator, the product of this history and conditions is astounding present day biodiversity (Beehler 2007; Novotny, *et al.* 2006; Parsons 1999). Fortunately, newcomers to this complexity (e.g., the current author) have the advantage of the recently published two volume work, *The Ecology of Papua* (Marshall & Beehler 2007). Three articles in *The Ecology of Papua* were especially useful in the present revision: Polhemus (2007) on New Guinea geological history, Polhemus and Allen (2007a) on freshwater biogeography, and Polhemus and Allen (2007b) on inland water ecosystems.

Polhemus and Allen (2007a), using distributions of freshwater fishes, crayfishes, and aquatic insects, proposed areas of freshwater biotic endemism for both Papua New Guinea (PNG) and Papua Province, Indonesia (PPI). In PNG, 15 areas of endemism were outlined (Fig. 420). The present study provides the opportunity to test these proposed areas against the distributions of the hyperdiverse aquatic beetle genus *Hydraena*.

*Hydraena* is perhaps a classic example of a very diverse insect group that can be collected in large numbers—if the researcher is knowledgeable about microhabitats and collecting techniques. One such person is Mick Bacchus, who concentrated on collecting hydraenids during the BMNH–University of Newcastle-upon-Tyne expedition (October 1964 to March 1965). In total, Mick collected 3,855 hydraenid specimens, which is 51% of the total available for this revision! Also, his collections represent 68 species of *Hydraena*, that is, 52% of the known PNG species! Much more recently, between 2002 and 2008, Michael Balke and his Papuan colleagues Katayo Sagata